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February 9, 1999

Dr. Luanne Williams
North Carolina Department of Health and Human Services
Occupational and Environmental Epidemiology Section
P.O. Box 29601
Raleigh, North Carolina 27626-0601

RE: Information Required to Do a Risk Assessment For a Proposed Surfactant Flood and Partitioning Interwell Tracer Test at Site 88, Building HP 25, Camp Lejeune, North Carolina

Dear Dr. Williams:

During the spring and summer of 1998 we conducted a conservative interwell tracer test (CITT) and partitioning interwell tracer test (PITT) at the site referenced above. This year we propose to complete the demonstration. This will entail the conduct of a surfactant flood to remove the dense non-aqueous phase liquid (DNAPL) contamination found in the shallow aquifer and a final PITT to measure the volume of any contamination which may remain after the flood. The final PITT, in combination with soil cores, will be used evaluate the ability of surfactants to remove the tetrachloroethylene contamination present as DNAPL.

Last week you should have received a packet of information required for a risk assessment of the work proposed. In it, a number of conservative and partitioning tracers are listed. However, n-butanol, a conservative tracer we would like to use was not listed. N-butanol would be injected during the 6 days of tracer injection for the proposed PITT. A total of 44 lbs. of the compound would be injected at a concentration of 1,000 mg/L. It is anticipated that the final average concentration of n-butanol in the demonstration area at the end of pumping would be 1 - 5 mg/L. It is estimated that this concentration would drop to an average concentration of 14 ug/L once the natural ground water movement has displaced the plume a distance of 335 feet down gradient (southwest). This estimate is conservative in that it assumes no biodegradation of the tracer.



I have attached a Material Safety Data Sheet for this tracer. If there are any questions or if additional information is required, please call me.

Sincerely,

A handwritten signature in black ink, appearing to read 'J. Londergan', written over the typed name.

John T. Londergan
Senior Hydrogeologist

cc: Ms. Laura Yeh, Naval Facilities Engineering Service Center
Ms. Diane Reid, North Carolina DEHNR
Ms. Amy Axon, North Carolina DEHNR
Mr. David Lown, North Carolina DEHNR
Ms. Kate Landman, Naval Facilities Engineering Command
Mr. Mick Senus, AC/S EMD Camp Lejeune
Ms. Kathy Chavarra, Baker Environmental
Mr. Fred Holzmer, Duke Engineering and Services



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Material Safety Data Sheets Collection:

Sheet No. 337
n-Butyl Alcohol

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Section 1. Material Identification

***n*-Butyl Alcohol (C₄H₉OH)** Description: Naturally occurring in Brazilian peppermint oil. Derived by several processes including reduction of butyraldehyde with sodium borohydride, from ethylene oxide and triethylaluminum, oxidation of tributyl borane, carbohydrate fermentation, condensation of acetaldehyde to crotonaldehyde with subsequent hydrogenation, or by passing ethyl alcohol over magnesium oxide/copper oxide at 617 °F (325 °C) and 128 atm. Used as a solvent for fats, oils, waxes, resins, shellac, varnish, gums, vegetable oils, alkaloids, and dyes; in manufacture of lacquers, rayon, detergents, other butyl compounds, and pharmaceuticals (extractant for antibiotics, vitamins, and hormones); in microscopy preparing paraffin imbedding materials; as a dehydrating agent; in medicine for control of post-operative otolaryngeal pain and for an anti-hemorrhagic effect in advanced cancer patients; in veterinary medicine as a bactericide. Other Designations: CAS No. 71-36-3, *n*-butanol, 1-butanol, butyl hydroxide, butyric alcohol, CCS 203, Henostyp, 1-hydroxybutane, methylolpropane, propylcarbinol, propyl methanol.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*⁽⁷³⁾ for a suppliers list.

Cautions: *n*-Butyl alcohol is irritating to the eyes and skin and can cause dermatitis. Central nervous system depression may occur at high concentrations. It is a highly flammable liquid.

R	1	NFP
I	2	3
S	2*	1
K	3	-
*Skin absorption		HMI
		H
		F
		R
		PPE†
		† Sec.

Section 2. Ingredients and Occupational Exposure Limits

n-Butyl alcohol, ca 99.9%. May contain 0.1% water by wt.

1992 OSHA PEL

Transitional Limit:

TWA, 100 ppm (300 mg/m³)

Final Rule Limit:

Ceiling, 50 ppm (150 mg/m³), skin

1990 IDLH Level

8000 ppm

1990 NIOSH REL

Ceiling: 50 ppm (150 mg/m³), skin

1992-93 ACGIH TLV

Ceiling: 50 ppm (152 mg/m³), skin

1990 DFG (Germany) MAK

TWA: 100 ppm (300 mg/m³)

Category II: substances with systemic effects

Half-life: < 2 hr

Peak Exposure Limit: 200 ppm, 30 min

average value, 4/shift

1992 Toxicity Data*

Human, eye, 50 ppm caused irritation.

Human, inhalation, TC_{Lo}: 25 ppm caused conjunctival and respiratory irritation.

Rat, oral, LD₅₀: 790 mg/kg; toxic effects not yet reviewed

Rabbit, skin, LD₅₀: 3400 mg/kg; no toxic effect noted

* See NIOSH, RTECS (EO1400000), for additional irritation, mutation, and toxicity data.

Section 3. Physical Data

Boiling Point: 243 °F (117 °C)

Freezing Point: -130 °F (-90 °C)

Vapor Pressure: 6.5 mm Hg at 77 °F (25 °C)

Ionization Potential: 10.04 eV

Relative Evaporation Rate (BuAc = 1): 0.46

Refraction Index: 1.3993 at 68 °F (20 °C)

Saturated Vapor Density (Air = 1.2 kg/m³): 1.216 kg/m³

Liquid Surface Tension: 69.3 dyne/cm

Molecular Weight: 74.12

Specific Gravity: 0.8109 at 68 °F (20 °C)

Water Solubility: Soluble, 9.1 mL/100 mL water

Other Solubilities: Soluble (10%) in acetone, benzene, ethanol, and eth

log Octanol Water Partition Coefficient: 0.88

Viscosity: 36.1 cP at -50.6 °F (-50.9 °C), 5.18 cP at 32 °F (0 °C), 2.94 c

at 68 °F (20 °C), 0.54 cP at 212 °F (100 °C).

Critical Temperature and Pressure: 289.8 °C and 43.6 atm

Appearance and Odor: Colorless liquid with a harsh fuel oil and banana smell. The odor threshold is 0.12 to 11 ppm.

Section 4. Fire and Explosion Data

Flash Point: 84 °F (28.9 °C) CC, 98 °F (37 °C) OC

Autoignition Temperature: 650 °F (343 °C)

LEL: 1.4% v/v

UEL: 11.2% v/v

Extinguishing Media: A Class I C Flammable Liquid. For small fires, use dry chemical, carbon dioxide, water spray, or 'alcohol-resistant' foam. For large fires, use water spray, fog, or 'alcohol-resistant' foam. Unusual Fire or Explosion Hazards: Burning Rate = 3.2 mm/min. Vapors may travel to an ignition source and flash back. Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing provides only limited protection. Cool container sides with water until well after fire is out. Stay away from ends c tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw and let burn. Withdraw immediately you hear a rising sound from venting safety device or notice tank discoloration due to fire because a BLEVE may be imminent. Do not release runoff from fire control methods to sewers or waterways; dike for proper disposal.

Section 5. Reactivity Data

Stability/Polymerization: *n*-Butyl alcohol is stable at room temperature in closed containers under normal storage and handling conditions.

Hazardous polymerization cannot occur. Chemical Incompatibilities: Include aluminum, chromium trioxide, organic peroxides, and strong oxidizers. Attacks some forms of plastic, rubber, coatings. Conditions to Avoid: Exposure to heat, ignition sources, and incompatibles.

Hazardous Products of Decomposition: Thermal oxidative decomposition of *n*-butyl alcohol can produce carbon monoxide and acrid smoke.

Section 6. Health Hazard Data

Carcinogenicity: The IARC⁽¹⁸³⁾ NTP⁽¹⁶⁹⁾ and OSHA⁽¹⁸³⁾ do not list *n*-butyl alcohol as a carcinogen. Summary of Risks: *n*-Butyl alcohol is potentially more toxic (seen in animal studies) than its lower homologues but its airborne hazards are substantially reduced due to a low vapor pressure. The estimated human lethal oral dose is 3 to 7 ounces. Vapor inhalation is irritating to the eyes and respiratory tract. Skin contact is irritating and may lead to dermatitis. *n*-Butyl alcohol can be absorbed through the skin; direct hand contact for 1 hr resulted in a body burden 4x that from inhalation of 50 ppm/1 hr. The average odor threshold is ~ 15 ppm but because of rapid olfactory fatigue it rises to 10,000 ppm after adaptation.

Continue on next page

Section 6. Health Hazard Data, continued

Two studies suggest unprotected noise exposure concurrent with exposure to butyl alcohol (~ 80 ppm) increased hearing loss beyond that occurring from noise exposure alone. Animal studies show lowered white blood cell counts, lymphocytosis, lung hemorrhage, albuminuria (albumin in urine), early degenerative liver changes, and cortical/tubular degeneration of the kidneys. Medical Conditions Aggravated by Long-Term Exposure: Dermatitis. Target Organs: Eyes, ears, skin, respiratory tract. Primary Entry Routes: Inhalation, eye contact, skin contact/absorption. Acute Effects: Skin contact produces drying and cracking due to its defatting action. Vapor inhalation is irritating to respiratory tract and eyes. Conjunctival edema (swelling), headache, dizziness, and drowsiness may also occur. Chronic Effects: Repeated exposure to 50 to 200 ppm leads to blurred vision, burning, and sensitivity to light. Symptoms become more severe toward week's end and decrease over the weekend. Hearing loss and vestibular damage resulting in vertigo may occur from current exposure to *n*-butyl alcohol and noise pollution.

FIRST AID Eyes: Do not allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water. If pain, photophobia, or lacrimation persists after 15 min. of flushing, consult an ophthalmologist. Skin: Quickly remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. Inhalation: Remove exposed person to fresh air and support breathing as needed. Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless otherwise advised, have that conscious and alert person drink 1 to 2 glasses of water to dilute. Do not induce vomiting. Note to Physicians: Treatment is symptomatic and supportive.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources. Take up small spills with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers. Dike far ahead of large spill for later disposal or reclamation. Prevent entry into sewers, drains, and waterways. Follow applicable OSHA regulations (29 CFR 1910.120).

Ecotoxicity Values: *Pseudomonas putida* (bacteria), 650 mg/L inhibited cell multiplication; fathead minnow, LC₅₀ = 1940 mg/L/1 hr; aquatic plant toxicity = 8500 ppm. **Environmental Degradation:** In air, *n*-butyl alcohol will react with photochemically produced hydroxyl radicals with an estimated half-life of 2.3 days. In a sunlit urban atmosphere the half-life is reduced to 5 hr. In water, some butyl alcohol will biodegrade and the rest will volatilize with estimated half-lives of 2.4 hr, 3.9 hr, and 125.9 days in streams, rivers, and lakes, respectively. The ability to volatilize depends on temperature, turbulence, wind speed, current velocity, and water depth. If released to soil, *n*-butyl alcohol may volatilize, biodegrade, or leach into groundwater. **Soil Absorption/Mobility:** A soil absorption coefficient (K_{oc}) of 71.6 indicates moderate to high mobility. **Disposal:** A good candidate for liquid injection incineration, with a temperature range of 650 to 1600 °C and a residence time of 0.1 to 2 sec; for rotary kiln incineration at 820 to 1600 °C for a few seconds, and for fluidized bed incineration at 450 to 980 °C for a few seconds. Land disposal is limited because sub-surface dilution does not adequately keep groundwater concentrations below regulated levels. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33): U031
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 5000 lb (2270 kg) [* per RCRA, Sec. 3001]

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 1000 ppm, use any powdered air purifying respirator with organic vapor cartridges. For < 1250 ppm, use any supplied-air respirator (SAR) operated in continuous-flow mode. For < 2500 ppm, use any air-purifying, full face respirator (gas mask) with a chin style, front or back mounted organic vapor canister, or any SAR or SCBA with a full facepiece. For < 8000 ppm, use any SAR with a full facepiece and operated in pressure-demand or positive pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. **Warning!** Air-purifying respirators do not protect workers in oxygen-deficient atmospheres. If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Teflon and chlorosulphonated ethylene rubber with a breakthrough time (BT) of > 8 hr; and butyl rubber, polyethylene, neoprene, and nitrile rubber with a BT of > 4 hr are suitable materials for protective gear. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾ **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage/Handling Requirements: Prevent physical damage to containers. Store in a cool, dry, dark, well-ventilated area away from heat, ignition sources, and incompatibles. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Use electrical equipment of Class I, Group D. Use non-sparking tools during maintenance operations and electrically ground and bond equipment. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers with emphasis on the eyes, skin and respiratory tract.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Butanols
DOT Hazard Class: 3
ID No.: UN1120
DOT Packing Group: III
DOT Label: Flammable Liquid
Special Provisions (172.102): B1, T1

Packaging Authorizations
a) Exceptions: 173.150
b) Non-bulk Packaging: 173.203
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger Aircraft or Railcar: 60 L
b) Cargo Aircraft Only: 220 L
Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: —

MSDS Collection References: 23, 54, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 148, 153, 159, 167, 168, 169, 171, 176, 183
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** AC Darlington, MD

**Products Applied to Ground Water or Soil
Containing No Microorganisms
Information To Do Risk Assessment**

Required General Information

1. Ms. Amy Axon
North Carolina DEHNR, Ground Water Section
Underground Injection Control Program
2728 Capitol Blvd.
Raleigh, NC 27626
Tel. 919-715-6165
2. Central Dry Cleaning Facility for Camp Lejeune, North Carolina
Mr. Mick Senus
AC/S EMD
Bldg. HP 67
Virginia Dare Road
Camp Lejeune, NC 28542
tel. 910-451-5068
3. Mr. John T. Londergan
Duke Engineering and Services
9111 Research Blvd.
Austin, Texas 78758
tel. 512-425-2028
4. The surfactant enhanced aquifer remediation (SEAR) demonstration and final partitioning interwell tracer test (PITT) will be conducted at Site 88, the location of the base central dry cleaning operations. Site 88 is within Operable Unit 15 as shown on the attached Figure 1. There are no active water supply wells located within a one mile radius of this site. The nearest active water supply well is HP-642 which is located approximately 1.5 miles east of the site.

There are no private wells within the confines of Camp Lejeune. All water on base is supplied by the Camp Lejeune water distribution system (analogous to a municipal water supply system).

The closest off-base property and hence the nearest possible private well, is approximately 4 miles from Site 88 to the northeast.

5. As of November 17, 1997 there was up to 2.8 feet of tetrachloroethene accumulation in wells located adjacent to the dry-cleaning facility at Site 88. Contaminant levels of up to 26,000 part per million (ppm) tetrachloroethene, 180 ppm trichloroethene, 46 ppm cis-1,2-dichloroethene, and 4.8 ppm vinyl chloride have been detected in soil samples collected from the shallow aquifer (8-18 ft BLS). . Varsol, a mineral spirits product produced by Exxon, is another contaminant present in the soils and groundwater. The Varsol contamination is found at the water table. Soil samples collected from this interval have been analyzed for diesel and gasoline range organics. Analyses for diesel range organics have detected up to 590 mg/kg. Analyses for gasoline range organics have detected up to 4,200 mg/kg.

6. There are no surface water bodies in the immediate vicinity of the site. The nearest bodies of surface water to Site 88 are Beaverdam Creek and The New River, located about 1,500 feet northeast and 3,000 ft west, respectively, from the site. The location of the site in relation to the New River is shown on attached Figure 1.

7. The dry-cleaning facility, Building HP25, is located in the area of contamination. Barracks are located approximately 200 feet away.

Required Product/Process Specific Information

The companies which will provide the compounds we propose to use and points of contact for each are given below. In addition, we have included some information from the recently submitted Work Plan for Surfactant Enhanced Aquifer Remediation and the previous year's PITT work plan pertaining to these items.

Item 1. Product Manufacturers and Contact Points

The surfactant will be purchased from Condea Vista:

Condea Vista Company
12024 Vista Park Drive
Austin, Texas 78726-4050

Contact Person: Dr. Larry Britton
Contact phone number: 512-331-2466

Corporate Toxicologist: Dr. David Penney
Phone number: 281-588-3059

The calcium chloride and 2-Propanol will be purchased from:

Van Waters & Rogers
3600 West Wendover Avenue
Greensboro, North Carolina 27407

Contact Person: Amy Norris
Contact phone number: 1-800-438-1119

All of the tracers will be purchased from Fisher Scientific. Please note that the calcium chloride injected during the PITT is not a tracer and will be purchased from Van Waters & Rogers.

Fisher Scientific
1 Reagent Lane
Fairlawn, NJ 07410

Contact Person: John Elfers
Contact phone number: 1-800-227-6701

Item 2. Identity of Specific Ingredients

Active Ingredients in Injectates

Injectate	Active Ingredients	Purpose
Surfactant & Cosolvent		
Isalchem 145	anionic surface active components consisting of homologues & isomers of the propoxylate sulfate plus small amounts (1-3%) of alcohol sulfate; expressed as the sodium salt	surfactant
2-Propanol	Isopropyl alcohol or 2-Propanol	cosolvent
Tracers		
2-Ethyl-1-Hexanol	2-Ethyl-1-Hexanol	partitioning tracer
Sodium Bromide	Sodium Bromide	conservative or non-partitioning tracer
1-Propanol	Propyl alcohol or 1-Propanol	nonconservative or partitioning tracer
1-Hexanol	Hexyl alcohol, n-Hexanol or 1-Hexanol	partitioning tracer
1-Heptanol	Heptyl alcohol, n-Heptanol or 1-Heptanol	partitioning tracer
Stabilizer & Electrolyte		
calcium chloride	calcium chloride	prevents mobilization of fine clay particles in the aquifer

Chemical Components in Isalchem 145-4PO-SO₄

In order to assist in evaluating the human health and environmental safety of the experimental surfactant Isalchem 145-4PO-SO₄, the table below was compiled to list all known constituents. These *typical values* are based on a 30% active solution which is envisioned as the concentration delivered for field use. The "active" will be all propoxylated sulfates (the average PO = 4) and sulfated alcohol. Not all of the alcohol is propoxylated; therefore, during sulfation the small, unpropoxylated alcohol is sulfated.

Component	Concentration	Measured (m) or Calculated (c)	Explanation of presence in surfactant
Active	30%	m	anionic surface active components consisting of homologues & isomers of the propoxylate sulfate plus small amounts (1-3%) of alcohol sulfate; expressed as the sodium salt
Free Oils	3%	m	un-sulfated material; alcohol propoxylates and traces of free alcohols.
Disulfo-polypropylene glycol	1%	c (PPG is measured in propylate)	Propoxylation process forms polypropylene glycol (PPG) which is subsequently sulfated. We assume all PPG is sulfated.
Sodium Sulfate	0.2%	m	formed during sulfation and neutralization
Sodium Carbonate	0.25% added	m	added as a pH buffering agent
Sodium Acetate	0.1%	c	Acetic acid is used to neutralize (quench) catalyst after propoxylation
Water	Remainder	-	

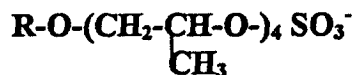
Description of the surfactant structure. Isalchem-4PO-SO₄ is an anionic surfactant belonging to the class of surfactants known as alcohol ether sulfates (AES). AES are currently the leading group of surfactants in laundry detergents, cleaning formulations and personal care products (shampoos, etc.) The general structure of AES is:



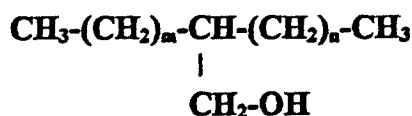
where R represents a linear or branched alkyl moiety of primary and secondary alcohols.

The repeating "alkoxamer" units can be oligomers of ethylene oxide (EO) as shown above, or they can be propylene oxide (PO) or mixtures of ethylene oxide and propylene oxide.

The Isalchem-4PO-SO₄ surfactant differs from the general structure above by containing oligomers of propylene oxide as shown in the structure below:



where R represents a defined branch alcohol of the following structure:



where $m + n = 10 - 11$ (i.e., the alcohol is C₁₄ - C₁₅);

and m, n = 0 to 11 (i.e., molecule may be linear or methyl, ethyl....branched)

These alcohols are commonly found in non-ionic and AES surfactants used in laundry detergents. They are branched components produced in the "oxo process" of alcohol manufacture. The Isalchem alcohols are simply the pure branched components that are separated from the oxo alcohols mixture. The presence of a single branch point, rather than multiple branching, gives desirable performance of the hydrophobe portion of the surfactant without poor biodegradability that is characteristic of highly branched hydrophobes.

Item 3. Toxicity Data

3.1 Ecotoxicity of the Surfactant

To the best of the manufacturer's knowledge, there are no ecotoxicity data on AES which have PO instead of EO except for Microtox™ screening tests performed at CONDEA Vista Company. Microtox™ assays on Isalchem-4-PO-SO₄ gave an EC₅₀ >>900 mg/L (CONDEA Vista Company, unpublished data). That is, the toxicity to the test bacteria *Vibrio fischeri* was minimal and the endpoint was unmeasurable, whereas the EC₅₀ for the common anionic surfactant sodium dodecyl sulfate was 0.3 mg/L.

The toxicity of the Isalchem-4PO-SO₄ surfactant can be put into perspective by examining the toxicity of an analogous AES containing a C₁₂ to C₁₅ alcohol and 3 – 5 moles of ethylene oxide. A total of 91 toxicity studies, both published and unpublished, were examined in Environmental Data Review of Alkyl Ether Sulfates (1994). Twenty-seven toxicity values for this range of AES were obtained, and are summarized below.

Taxonomic Group	Acute Toxicity, EC ₅₀ (mg/L)	No Observed Effect Conc. (mg/L)
algae	10 – 65	(no data)
<i>Daphnia magna</i>	5 – 37	(no data)
fish	1.5 – 68	(no data)

These values are for "linear" alcohol hydrophobes and with ethylene oxide (EO) in the hydrophilic portion. The Isalchem surfactant has a branched alcohol hydrophobe and propylene oxide (PO). The effects of PO (instead of EO) and of branching have been studied. In a review of alcohol ethoxylate surfactants, the author (Talmadge, 1994) stated that surfactants containing EO/PO block copolymers are less toxic than those containing only EO. Since surface tension properties are decreased with added PO, this statement makes sense. That is, when the surfactancy of the molecule is reduced, toxicity (which is an indirect measure of surfactancy) is also reduced. However, in all fairness, the data to back up this statement is scant, and none of the information applies to AES. Guhl and Gode (1989) looked at the toxicity of fifteen diverse surfactants including some with varying ratios of EO/PO. The acute toxicities for fish, daphnia and algae appear to be

less for comparable alcohol ethoxylates when PO is substituted in the molecules. A commercial $C_{8-12}EO_{3.6}PO_{1.4}EO_{3.6}$ non-ionic surfactant had LC_{50} values of 2.6 and 2.3 mg/L for daphnia and bluegill sunfish respectively, and this is comparable, if not less toxic, to analogous AE with all EO (Naylor et al., 1988). In another test, a $C_{8-10}EO_4PO_{1.5}EO_4$ showed no acute toxicity to daphnia at 20 mg/L, and it is highly probable that this concentration of an analogous AE with all EO would have demonstrated toxicity (Vista Technical Service Report TSR-6816-2-86, 1986).

Studies have shown that branching of the hydrophobe decreases toxicity in surfactants. For example, linear alcohol ethoxylates were shown to be 5 times, 11 times and 17 times more toxic than comparative branched AE for fathead minnow, daphnia and bacteria (Microtox™) respectively (Kravetz et al, 1991; Dorn et al, 1993). These tests compared AE containing "oxo" alcohols (referred to as linear although they have ~10% branching) with the highly branched tetrapropylene hydrophobe which has methyl branching at four locations. The Isalchem alcohol has a *single* branch point with possibilities of methyl, ethyl, propyl, etc. branch lengths. Therefore, one could postulate that toxicity would be intermediate between those with linear and highly branched hydrophobes.

3.2 2-Propanol

2-Propanol will be used as a cosolvent during the surfactant flood. Adding a cosolvent to the surfactant mixture is essential as it helps prevent the formation of surfactant gels and liquid crystals in-situ. It also reduces the viscosity of the microemulsion formed.

The results from some environmental studies with 2-Propanol are summarized in the following table. These results are from Verschueren (1983).

Biological Effects of Isopropanol	
Toxicity Threshold (cell multiplication inhibition test)	2-Propanol mg/L
Bacteria (<i>Pseudomonas putida</i>)	1050
Algae (<i>Microcystis aeruginosa</i>)	1000
Green algae (<i>Scenedesmus quadricauda</i>)	1800
Protozoa (<i>Uronema parduczi</i> Chatton L-woff)	3425

In addition to the above information the following information describes the toxicity of the 2-Propanol and some of its components.

Isopropanol (IPA) guppy (Poecilia reticulata) 7 day LC_{50} , 7,060 ppm

Inhalation, mouse:

LC_{50} = no reaction, 2,050 ppm, 480 min; Oral, Rat: LD_{50} = 5840 mg/kg;

Oral, rabbit: LD_{50} = 10.0 mg/kg;

3.3 Partitioning Tracers

Biological Effects of Some Partitioning Tracers

Toxicity Threshold* (cell multiplication inhibition test)	1-Hexanol mg/L	1-Heptanol mg/L
bacteria (<i>Pseudomonas putida</i>)	62	67
algae (<i>Micrcystis aeruginosa</i>)	12	3.5
green algae (<i>Scenedesmus quadricauda</i>)	30	17
protozoa (<i>Uronema parduczi</i> Chatton-L woff)	75	31

*Verschueren, K. 1983. "Handbook of Environmental Data on Organic Chemicals", Van Nostrand Reinhold, New York.

3.4 Calcium Chloride

Calcium is required in the injectate for two reasons. First, it prevents the deflocculation of clay minerals present in the aquifer. If calcium is not used, fines are mobilized in the aquifer which then lodge in pore spaces small enough to capture them. This leads to a significant degradation in hydraulic conductivity making the injection/extraction operations required to remediate the shallow aquifer impractical. Second, calcium is used as an electrolyte during the surfactant flood. The presence of such an electrolyte greatly increases the ability of the surfactant solution to solubilize the contamination. Enhancing the solubilization potential of the surfactant solution significantly decreases the amount of time required to remediate the contamination.

The total duration for injection and extraction operations during the SEAR demonstration and post-SEAR PITT is approximately 118 days. During the majority of the demonstration (64 days), a 1,000 mg/L calcium chloride solution will be injected to prevent the mobilization of fines and the consequential reduction in hydraulic conductivity in the aquifer. As reported last year, the dry bulk calcium chloride can contain up to a maximum of 3 mg/kg arsenic. Making the worse case assumption that all of the calcium chloride used is at the 3 mg/L maximum, would imply a maximum arsenic concentration in the injectate of 3 ug/L. During a six day period prior to the injection of surfactant and the design surfactant injection period of 48 days, the design calls for 2,200 mg/L of calcium chloride in the injectate. Once again, making the worse case assumption that all of the calcium chloride used is at the 3 mg/L maximum, would imply a maximum arsenic concentration in the injectate during this period of less than 7 ug/L.

The injection/extraction operations will be performed only in the shallow aquifer. This aquifer consists of approximately ten feet of saturated fine sand and silt found at a depth of 8 to 18 feet below ground surface. There is a competent clay layer at the base of the aquifer which separates it from the underlying Castle-Hayne aquifer. The clay layer is able to support a head difference of 8 feet between the aquifers.

Based on available information for Calcium Chloride anhydrous, this material will not biodegrade or bioaccumulate. The LC_{50} /96-hour values for fish are over 100 mg/L, and anhydrous: oral rat LD_{50} is 1000 mg/kg.

3.4.1 Sources for Calcium

We have investigated numerous grades and sources for calcium. The purest grade of calcium we have found in the quantities required for this work is food grade. None of the sources for calcium we found state a maximum possible concentration of arsenic less than 3 mg/L. This criteria is apparently based on the Food Chemical Codex limit stipulated for food grade calcium chloride. Additional sources for calcium chloride investigated are calcium sulfate and calcium carbonate. A copy of the page from the Food Chemicals Codex for food grade calcium chloride showing the 3 mg/L maximum permissible concentration of arsenic is attached.

3.4.2 Results of Arsenic Analyses During 1998

Ground water samples from shallow aquifer wells in the area of the demonstration were collected and analyzed for the presence of arsenic during the work conducted in 1998. The results are given in the following table.

Arsenic Analyses for Perimeter Monitoring Wells			
Sample ID	Date and Time	Date	Arsenic (ppm)
	Sampled	Analyzed	
MW02 (S)	4/10/98	4/20/98	nd
MW03 (S)	4/10/98	4/20/98	nd
MW05 (S)	4/10/98	4/20/98	nd
MW02-4	5/29/98	6/8/98	nd
MW03-4	5/29/98	6/8/98	nd
MW05-4	5/29/98	6/8/98	nd
MW02/07	6/26/98	7/14/98	nd
MW03/05	6/26/98	7/14/98	nd
MW05/05	6/26/98	7/14/98	nd

Note: Detection Limit for Arsenic = 0.005 ppm

Monitor wells MW02, MW03, and MW-05 surround the demonstration area as shown on the attached Figure 2. The samples collected April 10, 1998 were collected before injection of the calcium chloride mixture began to establish background concentrations. The samples collected May 29, 1998 were collected during injection operations. The samples collected June 26, 1998 were collected immediately after injection operations ceased. Arsenic was not detected in any of the samples to a detection limit of 5 parts per billion (ppb).

Item 4. Percentage of Products Recovered

As an introduction to the planned application of the compounds described above, the following table has been prepared.

Demonstration Design		
Activity	Duration in Days	Injectate
Water Flooding	6	Potable Water + 0.1 wt% calcium chloride
Surfactant Flood	48	Potable Water + 4 wt% Isalchem 145 + 16 wt% 2-propanol + 0.22 wt% calcium chloride
Water Flooding	16	Potable Water + 0.1 wt% calcium chloride
Tracer Injection	6	Potable Water + 0.1 wt% calcium chloride + tracers listed in Item 2 at 0.16 wt% or less of each tracer
Water Flooding	42	Potable Water + 0.1 wt% calcium chloride

During the initial water flood and surfactant flood, the total injection and extraction rates will be balanced at 1.0 gallon per minute (gpm). During the remainder of the demonstration, the total balanced injection and extraction rates will be raised to 1.55 gpm.

Based on numerical simulations conducted using a three-dimensional multi-phase simulation code known as UTCHEM, it is anticipated that 99% of the 2-Propanol injected will be recovered by the end of extraction operations. In similar manner, it is estimated that 98% of the surfactant injected will be recovered. Simulations using the same

numerical simulator predict that 95% of the injected tracers will be recovered by the end of the demonstration.

Item 5. Concentrations of Products Remaining

The final surfactant concentration in the demonstration area will be approximately 260 mg/L. The final concentration of 2-Propanol will be some 1,075 mg/L. The final tracer concentrations will be approximately 1-5 mg/L. The final calcium chloride concentration will be approximately 1,000 mg/L.

Item 6. Estimates of Downgradient Concentrations of Products Remaining

The surfactant flood and final PITT will be conducted in a well field constructed during the course of this project, as shown in attached Figure 3. The well field consists of three injection wells and six extraction wells arranged in a pattern known as a line-drive geometry. The rows of injection wells and extraction wells are spaced 15 feet apart, while neighboring injection and extraction wells will be spaced 10 ft apart. A hydraulic control well is installed at each end of the line of three injection wells to help contain the injected fluids and maximize injectate recovery.

At no time will the product concentrations in the groundwater exceed the injected concentrations. The concentrations and quantities of injectates to be used during the Site 88 PITT are provided in the table below.

Concentrations and Quantities of Injectates to be Used for Site 88 PITT

Tracer	Injected Concentrations mg/L	Quantity (lbs) to be injected
Isalchem 145	40,000	9,212 (active)
2-Propanol	160,000	36,849
2-Ethyl-1-Hexanol	250	11
Potassium Bromide	1,600	69
1-Propanol	1,300	56
1-Hexanol	1,000	44
1-Heptanol	800	35
calcium chloride*	1,000 to 2,200	2,615

- Quantity listed reflects the total amount required for the entire demonstration and not just the period of tracer injection.

The ground water flow direction in the vicinity of Building HP25 is to the southwest. When the demonstration is completed and extraction operations cease, the remaining concentrations of surfactant, 2-Propanol, calcium chloride, and tracers will be dispersed downgradient. To estimate the concentrations of these compounds which will be found at a distance once natural ground water flow has dispersed the plume, the analytical solution of De Josselin De Jong (1958) was used.

It is estimated that the average surfactant concentration remaining in the demonstration area when extraction operations cease will be 260 mg/L. Analysis, as described above, determined that once the natural ground water movement has displaced the plume a distance of 335 feet down gradient (southwest), the surfactant concentration will be approximately 0.7 mg/L. This calculation is conservative in that it assumes no biodegradation of the surfactant.

The biodegradation of AES has been well studied, and like all surfactants the structure of AES is a determining factor in biodegradability. Studies consistently show that biodegradation rates decrease with the presence and extent of PO as compared to EO (Naylor *et al*, 1988; Yoshimura and Masuda, 1982; Gerike and Jakob, 1988; and CONDEA Vista Company, Research Report, 1997). Nonetheless, AES containing PO are completely biodegradable, and the PO molecule itself, or oligomers of PO, are readily biodegradable as evidenced by the biodegradation studies on lengthy EO/PO block polymers known as Pluronics (Procter & Gamble, unpublished data *cited in* Environmental Data Review of Alkyl Ether Sulfates (1994)).

The branching of the alkyl hydrophobe is known to decrease biodegradation rates in a variety of surfactants (Swisher, 1987). Generally, these studies are with highly branched

hydrophobes such as the tetrapropylene of tributylene alkyl groups. The single branch in Isalchem-4PO-SO₄ may not be an obstacle for biodegradation. However, in the absence of data it is safer to assume slower biodegradation.

It is estimated that the average concentration of 2-Propanol remaining in the demonstration area when extraction operations cease will be 1,075 mg/L. Analysis, as described above, determined that once the natural ground water movement has displaced the plume a distance of 335 feet down gradient (southwest), the concentration of 2-Propanol will be approximately 3 mg/L. This calculation is conservative in that it assumes no biodegradation of the 2-Propanol.

It is estimated that the average concentration of tracers remaining in the demonstration area when extraction operations cease will be 1 to 5 mg/L. Analysis, as described above, determined that once the natural ground water movement has displaced the plume a distance of 335 feet down gradient (southwest), the concentrations of the individual tracers will be approximately 14 ug/L. This calculation is conservative in that it assumes no biodegradation of the tracers.

It is estimated that the average concentration of calcium chloride remaining in the demonstration area when extraction operations cease will be 1,000 mg/L. Analysis, as described above, determined that once the natural ground water movement has displaced the plume a distance of 335 feet down gradient (southwest), the concentration of calcium chloride will be approximately 3 mg/L.

Item 7. Discharges to Surface Water

It is not anticipated that the compounds used during the demonstration will be discharged either to Beaverdam Creek or to the New River.

Item 8 Degradation Products Expected

The product manufacturers will provide responses to these items.

Item 9. Migratory Potential of Specific Ingredients and Degradation Products

The product manufacturers will provide responses to these items.

Item 10. Project Summary

A surfactant enhanced aquifer remediation (SEAR) demonstration will be conducted at Site 88, which is the location of the central dry cleaning facility (Building 25) at Marine Corps Base (MCB) Camp Lejeune. Dry cleaning operations have been conducted there since the 1940's, using first Varsol, and then tetrachloroethene (PCE), as dry cleaning fluids. Recent environmental investigations have detected the presence of both compounds in the subsurface. In particular, PCE is present as a dense nonaqueous phase liquid (DNAPL) in the shallow aquifer, beneath and in the immediate vicinity of Building 25.

The Naval Facilities Engineering Service Center (NFESC), in collaboration with the U.S. Environmental Protection Agency (EPA) National Risk Management Research Laboratory (NRMRL), is investigating the use of SEAR technology for the remediation of sites contaminated with DNAPL. This work is being conducted under the DOD's Environmental Security Technology Certification Program (ESTCP). The purpose is to perform additional validation of SEAR in order to promote its commercialization for the rapid cleanup of DNAPL sites owned by the government and industry. Site 88 has been selected as a suitable site to conduct a demonstration of SEAR technology. In addition to subsurface remediation by surfactants, this demonstration will include procedures to treat the surfactant/DNAPL effluent stream extracted from the subsurface in order to recover surfactant for reuse in the SEAR demonstration. Attached Figure 1 shows the location of the site, also known as Operable Unit 15 (OU 15).

To assess the performance of SEAR at Site 88, the quantity of DNAPL contamination removed from the test zone will be determined by comparing DNAPL saturations before and after the surfactant flood. DNAPL saturations will be measured using soil borings and partitioning interwell tracer tests (PITT). It is expected that the PITT data will provide the most accurate estimate of DNAPL mass removed by application of surfactants, while the soil boring data will permit an evaluation of vertical changes in the DNAPL distribution. The pre-surfactant flood PITT (PITT1) was conducted by Duke Engineering & Services (DE&S) during the spring of 1998. Results of PITT1 indicate that there is approximately 87 gallons of DNAPL in the test zone, and DNAPL saturations range from about 0.5 to 5%, i.e., 0.5 to 5% of the pore space in the test zone is filled with DNAPL (DE&S, 1998a). Both the soil boring and PITT data indicate that most of the DNAPL lies in the low permeability sediments at the bottom of the shallow aquifer, near the aquifer-aquitard interface.

The SEAR demonstration will be conducted in the 20 x 30 ft test zone constructed for this effort. The demonstration wellfield is comprised of three injection wells, six extraction wells, and two hydraulic control (or water injection) wells. Attached Figure 3 shows the location of the wellfield with respect to Building 25. The surfactant injectate will be composed of a mixture of surfactant, water, alcohol, and salt that is optimally designed to dramatically increase the solubility of the DNAPL for rapid DNAPL removal. The surfactant mixture will be injected at wells IN-1, IN-2, and IN-3. It will be extracted at wells EX-1 through EX-6. Potable water mixed with calcium chloride will be injected at

hydraulic control wells HC-1 and HC-2 to minimize the lateral movement of the surfactant solution out of the demonstration area. The surfactant flood is designed to hydraulically sweep the test zone with 3-5 pore volumes of surfactant, and will be followed by a water flood to continue the recovery of surfactant and DNAPL. The effluent produced at the extraction wells, composed of the surfactant solution, DNAPL and groundwater, will be treated on site using two membrane processes, pervaporation and ultrafiltration. The pervaporation process will remove DNAPL from the surfactant, while the ultrafiltration treatment will remove excess water from the surfactant. Regenerated surfactant will be reinjected into the test zone during the course of the surfactant flood.

Samples will be collected during the SEAR demonstration to monitor the recovery of surfactant and DNAPL. Immediately upon the completion of the SEAR water flood, the post-SEAR PITT (PITT2) will be conducted for performance assessment of the SEAR. PITT2 will be conducted according to the protocol in the PITT Work Plan (DE&S, 1998b), as implemented during PITT1.

The final PITT will involve the injection of the suite of tracers listed in Section 2 above at wells IN-1, IN-2, and IN-3. The tracers will be extracted at wells EX-1 through EX-6. As for the surfactant flood, potable water mixed with calcium chloride will simultaneously be injected at the hydraulic control wells HC-1 and HC-2. Conservative (i.e., non-partitioning) tracers will pass unretarded through the DNAPL zone, whereas the partitioning tracers will be retarded due to their partitioning into and out of any DNAPL which may remain in the section. The arrival times and concentrations of the tracers at the extraction wells will be used to measure the volume and distribution of DNAPL in the interwell zone.

This project has participants from many organizations. In addition to those already mentioned, assistance is being provided by the University of Texas at Austin (UT), the University of Oklahoma, Norman (OU), Atlantic Division, Naval Facilities Engineering Command (LANTDIV) and the Marine Corps Base (MCB) Camp Lejeune. Field operations are being headed by DE&S, with support from Baker Environmental, OHM Remediation Services and International Technology (IT) Corp. The surfactant flood has been designed primarily by Dr. Gary Pope of the Department of Petroleum and Geosystems Engineering at UT, with support from Dr. Jeff Harwell of the Department of Chemical Engineering at OU. Surfactant treatment and recycling is being performed collaboratively by Dr. Leland Vane of EPA, NRMRL, in Cincinnati, and Dr. Edwin Tucker of the Chemistry and Biochemistry Department at OU. DE&S, in partnership with Baker Environmental, will conduct the surfactant flood and post-surfactant flood PITT. IT Corp. will provide field assistance for pervaporation during the surfactant flood. OHM Remediation Services will provide final treatment and disposal of wastewater from the demonstration.

The SEAR demonstration results will be evaluated to determine the effectiveness of SEAR for remediating DNAPL contaminated sites. An assessment of technical and cost issues,

including the feasibility and benefit of incorporating surfactant recycle process, associated with SEAR implementation, will be performed.

This work plan details the activities to be undertaken to perform the SEAR demonstration at Site 88. Field operations are scheduled to begin with system setup in March 1999. The surfactant flood and PITT2 are scheduled for completion in July 1999. Attached Figure 4 is a project timeline showing the different phases of the work and the estimated times of completion.

Reference

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**Products Applied to Ground Water or Soil
Containing No Microorganisms
Information To Do Risk Assessment**

Required General Information

1. Ms. Amy Axon
North Carolina DEHNR, Ground Water Section
Underground Injection Control Program
2728 Capitol Blvd.
Raleigh, NC 27626
Tel. 919-715-6165

2. Central Dry Cleaning Facility for Camp Lejeune, North Carolina
Mr. Mick Senus
AC/S EMD
Bldg. HP 67
Virginia Dare Road
Camp Lejeune, NC 28542
tel. 910-451-5068

3. Mr. John T. Londergan
Duke Engineering and Services
9111 Research Blvd.
Austin, Texas 78758
tel. 512-425-2028

4. The surfactant enhanced aquifer remediation (SEAR) demonstration and final partitioning interwell tracer test (PITT) will be conducted at Site 88, the location of the base central dry cleaning operations. Site 88 is within Operable Unit 15 as shown on the attached Figure 1. There are no active water supply wells located within a one mile radius of this site. The nearest active water supply well is HP-642 which is located approximately 1.5 miles east of the site.

There are no private wells within the confines of Camp Lejeune. All water on base is supplied by the Camp Lejeune water distribution system (analogous to a municipal water supply system).

The closest off-base property and hence the nearest possible private well, is approximately 4 miles from Site 88 to the northeast.

5. As of November 17, 1997 there was up to 2.8 feet of tetrachloroethene (PCE) accumulation in wells located adjacent to the dry-cleaning facility at Site 88. Contaminant levels of up to 26,000 parts per million (ppm) PCE, 180 ppm trichloroethene (TCE), 46 ppm cis-1,2-dichloroethene (DCE), and 4.8 ppm vinyl chloride have been detected in soil samples collected from the shallow aquifer (8-18 ft BLS). Varsol, a petroleum distillate or mineral spirits product produced by Exxon, is another contaminant present in the soils and groundwater. The Varsol contamination is found at the water table. Soil samples collected from this interval have been analyzed for diesel and gasoline range organics. Analyses for diesel range organics have detected up to 590 mg/kg. Analyses for gasoline range organics have detected up to 4,200 mg/kg.

6. There are no surface water bodies in the immediate vicinity of the site. The nearest bodies of surface water to Site 88 are Beaverdam Creek and The New River, located about 1,500 feet northeast and 3,000 ft west, respectively, from the site. The location of the site in relation to the New River is shown on attached Figure 1.

7. The dry-cleaning facility, Building 25, is located in the area of contamination. Barracks are located approximately 200 feet away.

Required Product/Process Specific Information

The companies which will provide the compounds we propose to use and points of contact for each are given below. In addition, we have included some information from the recently submitted Work Plan for Surfactant Enhanced Aquifer Remediation and the previous year's PITT work plan pertaining to these items.

Item 1. Product Manufacturers and Contact Points

The surfactant will be purchased from Condea Vista:

Condea Vista Company
12024 Vista Park Drive
Austin, Texas 78726-4050

Contact Person: Dr. Larry Britton
Contact phone number: 512-331-2466

Corporate Toxicologist: Dr. David Penney
Phone number: 281-588-3059

The calcium chloride and 2-Propanol will be purchased from:

Van Waters & Rogers
3600 West Wendover Avenue
Greensboro, North Carolina 27407

Contact Person: Amy Norris
Contact phone number: 1-800-438-1119

All of the tracers will be purchased from Fisher Scientific. Please note that the calcium chloride injected during the PITT is not a tracer and will be purchased from Van Waters & Rogers.

Fisher Scientific
1 Reagent Lane
Fairlawn, NJ 07410

Contact Person: John Elfers
Contact phone number: 1-800-227-6701

Item 2. Identity of Specific Ingredients

Active Ingredients in Injectates

Injectate	Active Ingredients	Purpose
Surfactant & Cosolvent		
Isalchem 145-4PO Sulfate	anionic surface active components consisting of homologues & isomers of the branched alcohol propoxylate sulfate plus small amounts (1-3%) of alcohol sulfate; expressed as the sodium salt	surfactant
2-Propanol	Isopropyl alcohol or 2-Propanol	cosolvent
Tracers		
2-Ethyl-1-Hexanol	2-Ethyl-1-Hexanol	partitioning tracer
Potassium Bromide	Potassium Bromide	conservative or non-partitioning tracer
1-Propanol	Propyl alcohol or 1-Propanol	conservative or nonpartitioning tracer
1-Hexanol	Hexyl alcohol, n-Hexanol or 1-Hexanol	partitioning tracer
1-Heptanol	Heptyl alcohol, n-Heptanol or 1-Heptanol	partitioning tracer
Stabilizer & Electrolyte		
calcium chloride	calcium chloride	Stabilizer: prevents mobilization of fine clay particles in the aquifer Electrolyte: optimize surfactant solubilization potential and phase behavior

Chemical Components in Isalchem 145-4PO-SO₄

In order to assist in evaluating the human health and environmental safety of the surfactant Isalchem 145-4PO-SO₄, the table below was compiled to list all known constituents. These *typical values* are based on a 30% active solution which is expected concentration delivered for field use. The "active" will be all branched alcohol propoxylated sulfates (the average PO = 4) and sulfated alcohol. Not all of the alcohol is propoxylated; therefore, during sulfation the small, unpropoxylated alcohol is sulfated.

Component	Concentration	Measured (m) or Calculated (c)	Explanation of presence in surfactant
Active	30%	m	anionic surface active components consisting of homologues & isomers of the branched alcohol propoxylate sulfate plus small amounts (1-3%) of alcohol sulfate; expressed as the sodium salt
Free Oils	3%	m	un-sulfated material; alcohol propoxylates and traces of free alcohols.
Disulfo-polypropylene glycol	1%	c (PPG is measured in propoxylate)	Propoxylation process forms polypropylene glycol (PPG) which is subsequently sulfated. We assume all PPG is sulfated.
Sodium Sulfate	0.2%	m	formed during sulfation and neutralization
Sodium Carbonate	0.25% added	m	added as a pH buffering agent
Sodium Acetate	0.1%	c	Acetic acid is used to neutralize (quench) catalyst after propoxylation
Water	Remainder	-	

Description of the surfactant structure. Isalchem-4PO-SO₄ is an anionic surfactant belonging to the class of surfactants known as alcohol ether sulfates (AES). AES are currently the leading group of surfactants in laundry detergents, cleaning formulations and personal care products (shampoos, etc.) The general structure of AES is:



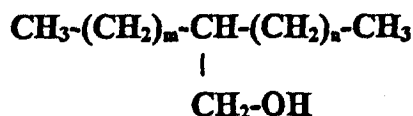
where R represents a linear or branched alkyl moiety of primary and secondary alcohols.

The repeating "alkoxamer" units can be oligomers of ethylene oxide (EO) as shown above, or they can be propylene oxide (PO) or mixtures of ethylene oxide and propylene oxide.

The Isalchem-4PO-SO₄ surfactant differs from the general structure above by containing oligomers of propylene oxide as shown in the structure below:



where R represents a defined branch alcohol of the following structure:



where $m + n = 10 - 11$ (i.e., the alcohol is C₁₄ - C₁₅);

and m, n = 0 to 11 (i.e., molecule may be linear or methyl, ethyl....branched)

These alcohols are commonly found in non-ionic and AES surfactants used in laundry detergents. They are branched components produced in the "oxo process" of alcohol manufacture. The Isalchem alcohols are simply the pure branched components that are separated from the oxo alcohols mixture. The presence of a single branch point, rather than multiple branching, gives desirable performance of the hydrophobe portion of the surfactant without poor biodegradability that is characteristic of highly branched hydrophobes.

Item 3. Toxicity Data

3.1 Ecotoxicity of the Surfactant

To the best of the manufacturer's knowledge, there are no ecotoxicity data on AES which have PO instead of EO except for Microtox™ screening tests performed at CONDEA Vista Company. Microtox™ assays on Isalchem-4-PO-SO₄ gave an EC₅₀ >>900 mg/L (CONDEA Vista Company, unpublished data). That is, the toxicity to the test bacteria *Vibrio fischeri* was minimal and the endpoint was unmeasurable, whereas the EC₅₀ for the common anionic surfactant sodium dodecyl sulfate was 0.3 mg/L.

The toxicity of the Isalchem-4PO-SO₄ surfactant can be put into perspective by examining the toxicity of an analogous AES containing a C₁₂ to C₁₅ alcohol and 3 – 5 moles of ethylene oxide. A total of 91 toxicity studies, both published and unpublished, were examined in Environmental Data Review of Alkyl Ether Sulfates (1994). Twenty-seven toxicity values for this range of AES were obtained, and are summarized below.

Taxonomic Group	Acute Toxicity, EC ₅₀ (mg/L)	No Observed Effect Conc. (mg/L)
algae	10 – 65	(no data)
<i>Daphnia magna</i>	5 – 37	(no data)
fish	1.5 – 68	(no data)

These values are for "linear" alcohol hydrophobes and with ethylene oxide (EO) in the hydrophilic portion. The Isalchem surfactant has a branched alcohol hydrophobe and propylene oxide (PO). The effects of PO (instead of EO) and of branching have been studied. In a review of alcohol ethoxylate surfactants, the author (Talmadge, 1994) stated that surfactants containing EO/PO block copolymers are less toxic than those containing only EO. Since surface tension properties are decreased with added PO, this statement makes sense. That is, when the surfactancy of the molecule is reduced, toxicity (which is an indirect measure of surfactancy) is also reduced. However, in all fairness, the data to back up this statement is scant, and none of the information applies to AES. Guhl and Gode (1989) looked at the toxicity of fifteen diverse surfactants including some with varying ratios of EO/PO. The acute toxicities for fish, daphnia and algae appear to be less

for comparable alcohol ethoxylates when PO is substituted in the molecules. A commercial $C_{12}EO_{3.6}PO_{1.4}EO_{3.6}$ non-ionic surfactant had LC_{50} values of 2.6 and 2.3 mg/L for daphnia and bluegill sunfish respectively, and this is comparable, if not less toxic, to analogous AE with all EO (Naylor et al., 1988). In another test, a $C_{10}EO_4PO_{1.5}EO_4$ showed no acute toxicity to daphnia at 20 mg/L, and it is highly probable that this concentration of an analogous AE with all EO would have demonstrated toxicity (Vista Technical Service Report TSR-6816-2-86, 1986).

Studies have shown that branching of the hydrophobe decreases toxicity in surfactants. For example, linear alcohol ethoxylates were shown to be 5 times, 11 times and 17 times more toxic than comparative branched AE for fathead minnow, daphnia and bacteria (Microtox™) respectively (Kravetz et al, 1991; Dorn et al, 1993). These tests compared AE containing "oxo" alcohols (referred to as linear although they have ~10% branching) with the highly branched tetrapropylene hydrophobe which has methyl branching at four locations. The Isalchem alcohol has a *single* branch point with possibilities of methyl, ethyl, propyl, etc. branch lengths. Therefore, one could postulate that toxicity would be intermediate between those with linear and highly branched hydrophobes.

3.2 2-Propanol

2-Propanol will be used as a cosolvent during the surfactant flood. Adding a cosolvent to the surfactant mixture is essential as it helps prevent the formation of surfactant gels and liquid crystals in-situ. It also reduces the viscosity of the microemulsion formed.

The results from some environmental studies with 2-Propanol are summarized in the following table. These results are from Verschueren (1983).

Biological Effects of Isopropanol	
Toxicity Threshold (cell multiplication inhibition test)	2-Propanol mg/L
Bacteria (<i>Pseudomonas putida</i>)	1050
Algae (<i>Microcystis aeruginosa</i>)	1000
Green algae (<i>Scenedesmus quadricauda</i>)	1800
Protozoa (<i>Uronema parduczi</i> Chatton L-woff)	3425

In addition to the above information the following information describes the toxicity of the 2-Propanol and some of its components.

Isopropanol (IPA) guppy (Poecilia reticulata) 7 day LC_{50} , 7,060 ppm

Inhalation, mouse:

LC_{50} = no reaction, 2,050 ppm, 480 min; Oral, Rat: LD_{50} = 5840 mg/kg;

Oral, rabbit: LD_{50} = 10.0 mg/kg;

3.3 Partitioning Tracers

Biological Effects of Some Partitioning Tracers

Toxicity Threshold* (cell multiplication inhibition test)	1-Hexanol mg/L	1-Heptanol mg/L
bacteria (<i>Pseudomonas putida</i>)	62	67
algae (<i>Micrcystis aeruginosa</i>)	12	3.5
green algae (<i>Scenedesmus quadricauda</i>)	30	17
protozoa (<i>Uronema parduczi</i> Chatton-L woff)	75	31

*Verschueren, K. 1983. "Handbook of Environmental Data on Organic Chemicals", Van Nostrand Reinhold, New York.

3.4 Calcium Chloride

Calcium is required in the injectate for two reasons. First, it prevents the deflocculation of clay minerals present in the aquifer. If calcium is not used, fines are mobilized in the aquifer which then lodge in pore spaces small enough to capture them. This leads to a significant reduction in hydraulic conductivity near the injection wells, thus making the injection/extraction operations required to remediate the shallow aquifer impractical. Second, calcium is used as an electrolyte during the surfactant flood. The presence of such an electrolyte greatly increases the ability of the surfactant solution to solubilize the dense non-aqueous phase liquid (DNAPL) contamination. Enhancing the solubilization potential of the surfactant solution significantly decreases the amount of time required to remediate the DNAPL contamination.

The total duration for injection and extraction operations during the SEAR demonstration and post-SEAR PITT is approximately 118 days. During the first 54 days of the demonstration, it is necessary to use 2,200 mg/L of calcium chloride in the injectate. As reported last year, the dry bulk calcium chloride can contain up to a maximum of 3 mg/kg arsenic. Making the worse case assumption that all of the calcium chloride used is at the 3 mg/L maximum, would imply a maximum arsenic concentration in the injectate of slightly less than 7 ug/L. During the remainder of the demonstration (64 days), a 1,000 mg/L calcium chloride solution will be injected. Once again, making the worse case assumption that all of the calcium chloride used is at the 3 mg/L maximum, would imply a maximum arsenic concentration in the injectate during this period of 3 ug/L.

The injection/extraction operations will be performed only in the shallow aquifer. This aquifer consists of approximately ten feet of saturated fine sand and silt found at a depth of 8 to 18 feet below ground surface. There is a competent clay layer at the base of the aquifer, which separates the shallow aquifer from the underlying Castle-Hayne aquifer. The clay layer is able to support a head difference of 8 feet between the aquifers, which is evidence of the competency of the clay layer as an aquitard separating the two aquifers.

Based on available information for Calcium Chloride anhydrous, this material will not biodegrade or bioaccumulate. The LC_{50} /96-hour values for fish are over 100 mg/L, and anhydrous: oral rat LD_{50} is 1000 mg/kg.

3.4.1 Sources for Calcium

We have investigated numerous grades and sources for calcium. The purest grade of calcium we have found in the quantities required for this work is food grade. None of the sources for calcium we found state a maximum possible concentration of arsenic less than 3 mg/kg. This criteria is apparently based on the Food Chemical Codex limit stipulated for food grade calcium chloride. Additional sources for calcium chloride investigated are calcium sulfate and calcium carbonate. A copy of the page from the Food Chemicals Codex for food grade calcium chloride showing the 3 mg/kg maximum permissible concentration of arsenic is attached.

3.4.2 Results of Arsenic Analyses During 1998

Ground water samples from shallow aquifer wells in the area of the demonstration were collected and analyzed for the presence of arsenic during the work conducted in 1998. The results are given in the following table.

Arsenic Analyses for Perimeter Monitoring Wells			
Sample ID	Date and Time	Date	Arsenic
	Sampled	Analyzed	(ppm)
MW02 (S)	4/10/98	4/20/98	nd
MW03 (S)	4/10/98	4/20/98	nd
MW05 (S)	4/10/98	4/20/98	nd
MW02-4	5/29/98	6/8/98	nd
MW03-4	5/29/98	6/8/98	nd
MW05-4	5/29/98	6/8/98	nd
MW02/07	6/26/98	7/14/98	nd
MW03/05	6/26/98	7/14/98	nd
MW05/05	6/26/98	7/14/98	nd

Note: Detection Limit for Arsenic = 0.005 mg/L

Monitor wells MW02, MW03, and MW-05 surround the demonstration area as shown on the attached Figure 2. The samples collected April 10, 1998 were collected before injection of the calcium chloride mixture began in order to establish background concentrations. The samples collected May 29, 1998 were collected during injection operations. The samples collected June 26, 1998 were collected immediately after injection operations ceased. Arsenic was not detected in any of the samples to a detection limit of 5 parts per billion (ppb).

Item 4. Percentage of Products Recovered

As an introduction to the planned application of the compounds described above, the following table has been prepared.

Demonstration Design		
Activity	Duration in Days	Injectate
Water Flooding	6	Potable Water + 0.22 wt% calcium chloride
Surfactant Flood	48	Potable Water + 4 wt% Isalchem 145 + 16 wt% 2-propanol + 0.22 wt% calcium chloride
Water Flooding	16	Potable Water + 0.1 wt% calcium chloride
Tracer Injection	6	Potable Water + 0.1 wt% calcium chloride + tracers listed in Item 2 at 0.16 wt% or less of each tracer
Water Flooding	42	Potable Water + 0.1 wt% calcium chloride

During the initial water flood and surfactant flood, the total injection and extraction rates will be 0.96 and 1.05 gallons per minute (gpm) respectively. During the remainder of the demonstration, the total injection and extraction rates will be raised to 1.44 and 1.55 gpm respectively.

Based on numerical simulations conducted using a three-dimensional multi-phase simulation code known as UTCHEM, it is anticipated that 99% of the 2-Propanol injected will be recovered by the end of extraction operations. In similar manner, it is estimated that 98% of the surfactant injected will be recovered. Simulations using the same numerical simulator predict that 95% of the injected tracers will be recovered by the end of the demonstration.

Item 5. Concentrations of Products Remaining

The final surfactant concentration in the demonstration area will be approximately 260 mg/L. The final concentration of 2-Propanol will be about 1,075 mg/L. The final tracer concentrations will be approximately 1-5 mg/L. The final calcium chloride concentration will be approximately 1,000 mg/L.

Item 6. Estimates of Downgradient Concentrations of Products Remaining

The surfactant flood and final PITT will be conducted in a well field constructed during the course of this project, as shown in attached Figure 3. The well field consists of three injection wells and six extraction wells arranged in a pattern known as a divergent line-drive geometry. The interwell distance between any pair of injection and extraction wells (I-E) is 15 feet, while neighboring injection (I-I) and extraction (E-E) wells are spaced 10 ft apart. A hydraulic control well is installed at each end of the line of three injection wells to provide hydraulic containment of the injected fluids and thereby maximize injectate recovery.

At no time will the product concentrations in the groundwater exceed the injected concentrations. The concentrations and quantities of injectates to be used during the Site 88 PITT are provided in the table below.

Concentrations and Quantities of Injectates to be Used for Site 88 PITT

Tracer	Injected Concentrations mg/L	Quantity (lbs) to be injected
Isalchem 145	40,000	9,212 (active)
2-Propanol	160,000	36,849
2-Ethyl-1-Hexanol	250	11
Potassium Bromide	1,600	69
1-Propanol	1,300	56
1-Hexanol	1,000	44
1-Heptanol	800	35
calcium chloride*	1,000 to 2,200	2,615

- Quantity listed reflects the total amount required for the entire demonstration and not just the period of tracer injection.

The ground water flow direction in the general vicinity of Building 25 is to the southwest. When the demonstration is completed and extraction operations cease, the remaining concentrations of surfactant, 2-Propanol, calcium chloride, and tracers will be dispersed downgradient. To estimate the concentrations of these compounds which will be found at a distance once natural ground water flow has dispersed the plume, the analytical solution of De Josselin De Jong (1958) was used.

It is estimated that the average surfactant concentration remaining in the demonstration area when extraction operations cease will be 260 mg/L. Analysis, as described above, predicts that once the natural ground water movement has displaced the plume a distance of 335 feet down gradient (southwest), the surfactant concentration will be approximately 0.7 mg/L. This calculation is conservative in that it assumes no biodegradation of the surfactant.

The biodegradation of AES has been well studied, and like all surfactants the structure of AES is a determining factor in biodegradability. Studies consistently show that biodegradation rates decrease with the presence and extent of PO as compared to EO (Naylor *et al*, 1988; Yoshimura and Masuda, 1982; Gerike and Jakob, 1988; and CONDEA Vista Company, Research Report, 1997). Nonetheless, AES containing PO are completely biodegradable, and the PO molecule itself, or oligomers of PO, are readily biodegradable as evidenced by the biodegradation studies on lengthy EO/PO block polymers known as Pluronic (Procter & Gamble, unpublished data *cited in* Environmental Data Review of Alkyl Ether Sulfates (1994)).

The branching of the alkyl hydrophobe is known to decrease biodegradation rates in a variety of surfactants (Swisher, 1987). Generally, these studies are with highly branched hydrophobes such as the tetrapropylene or tributylene alkyl groups. The single branch in Isalchem-4PO-SO₄ may not be an obstacle for biodegradation. However, in the absence of data it is safer to assume slower biodegradation.

It is estimated that the average concentration of 2-Propanol remaining in the demonstration area when extraction operations cease will be 1,075 mg/L. Analysis, as described above, predicts that once the natural ground water movement has displaced the plume a distance of 335 feet down gradient (southwest), the concentration of 2-Propanol will be approximately 3 mg/L. This calculation is conservative in that it assumes no biodegradation of the 2-Propanol.

It is estimated that the average concentration of tracers remaining in the demonstration area when extraction operations cease will be 1 to 5 mg/L. Analysis, as described above, predicts that once the natural ground water movement has displaced the plume a distance of 335 feet down gradient (southwest), the concentrations of the individual tracers will be approximately 14 ug/L. This calculation is conservative in that it assumes no biodegradation of the tracers.

It is estimated that the average concentration of calcium chloride remaining in the demonstration area when extraction operations cease will be 1,000 mg/L. Analysis, as described above, predicts that once the natural ground water movement has displaced the plume a distance of 335 feet down gradient (southwest), the concentration of calcium chloride will be approximately 3 mg/L.

Item 7. Discharges to Surface Water

It is not anticipated that the compounds used during the demonstration will be discharged either to Beaverdam Creek or to the New River.

Item 8 Degradation Products Expected

The product manufacturers will provide responses to these items.

Item 9. Migratory Potential of Specific Ingredients and Degradation Products

The product manufacturers will provide responses to these items.

Item 10. Project Summary

A surfactant enhanced aquifer remediation (SEAR) demonstration will be conducted at Site 88, which is the location of the central dry cleaning facility (Building 25) at Marine Corps Base (MCB) Camp Lejeune. Dry cleaning operations have been conducted there since the 1940's, using first Varsol, and then tetrachloroethene (PCE), as dry cleaning fluids. Recent environmental investigations have detected the presence of both compounds in the subsurface. In particular, PCE is present as a dense nonaqueous phase liquid (DNAPL) in the shallow aquifer, beneath and in the immediate vicinity of Building 25.

The Naval Facilities Engineering Service Center (NFESC), in collaboration with the U.S. Environmental Protection Agency (EPA) National Risk Management Research Laboratory (NRMRL), is investigating the use of SEAR technology for the remediation of sites contaminated with DNAPL. This work is being conducted under the DOD's Environmental Security Technology Certification Program (ESTCP). The purpose is to perform additional validation of SEAR in order to promote its commercialization for the rapid cleanup of DNAPL sites owned by the government and industry. Site 88 has been selected as a suitable site to conduct a demonstration of SEAR technology. In addition to subsurface remediation by surfactants, this demonstration will include procedures to treat the surfactant/DNAPL effluent stream extracted from the subsurface in order to recover surfactant for reuse in the SEAR demonstration. Attached Figure 1 shows the location of the site, also known as Operable Unit 15 (OU 15).

To assess the performance of SEAR at Site 88, the quantity of DNAPL contamination removed from the test zone will be determined by comparing DNAPL saturations before and after the surfactant flood. DNAPL saturations will be measured by using both soil borings and partitioning interwell tracer tests (PITT). It is expected that the PITT data will provide the most accurate estimate of DNAPL mass removed by application of surfactants, while the soil boring data will permit an evaluation of vertical changes in the DNAPL distribution. The pre-surfactant flood PITT (PITT1) was conducted by Duke Engineering & Services (DE&S) during the spring of 1998. Results of PITT1 indicate that there is approximately 87 gallons of DNAPL in the test zone, and DNAPL saturations range from about 0.5 to 5%, i.e., 0.5 to 5% of the pore space in the test zone is filled with DNAPL (DE&S, 1998a). Both the soil boring and PITT data indicate that most of the DNAPL lies in the low permeability sediments at the base of the shallow aquifer, near the aquifer-aquitard interface.

The SEAR demonstration will be conducted in the 20 x 30 ft test zone constructed for this effort. The demonstration wellfield is comprised of three injection wells, six extraction wells, and two hydraulic control (or water injection) wells. Attached Figure 3 shows the location of the wellfield with respect to Building 25. The surfactant injectate will be composed of a mixture of surfactant, water, alcohol, and salt that is optimally designed to dramatically increase the solubility of the DNAPL for rapid DNAPL remediation. The surfactant mixture will be injected at wells IN-1, IN-2, and IN-3. It will be extracted at wells EX-1 through EX-6. Potable water mixed with calcium chloride will be injected at

hydraulic control wells HC-1 and HC-2 to minimize the lateral movement of the surfactant solution out of the demonstration area. The surfactant flood is designed to hydraulically sweep the test zone with 3-5 pore volumes of surfactant, and will be followed by a water flood to continue the recovery of surfactant and DNAPL. The effluent produced at the extraction wells, composed of the surfactant solution, DNAPL and groundwater, will be treated on site using two membrane processes, pervaporation and ultrafiltration. The pervaporation process will remove DNAPL from the surfactant, while the ultrafiltration treatment will remove excess water from the surfactant. Regenerated surfactant will be reinjected into the test zone during the course of the surfactant flood.

Samples will be collected during the SEAR demonstration to monitor the recovery of surfactant and DNAPL. Immediately upon the completion of the post-SEAR water flood, the post-SEAR PITT (PITT2) will be conducted for performance assessment of the SEAR. PITT2 will be conducted according to the protocol in the PITT Work Plan (DE&S, 1998b), as implemented during PITT1.

The final PITT will involve the injection of the suite of tracers listed in Section 2 above at wells IN-1, IN-2, and IN-3. The tracers will be extracted at wells EX-1 through EX-6. Potable water mixed with calcium chloride will simultaneously be injected at the hydraulic control wells HC-1 and HC-2. Conservative (i.e., non-partitioning) tracers will pass unretarded through the DNAPL zone, whereas the partitioning tracers will be retarded due to their partitioning into and out of any DNAPL which may remain in the section. The arrival times and concentrations of the tracers at the extraction wells will be used to measure the volume and distribution of DNAPL in the interwell zone.

This project has participants from many organizations. In addition to those already mentioned, assistance is being provided by the University of Texas at Austin (UT), the University of Oklahoma, Norman (OU), Atlantic Division, Naval Facilities Engineering Command (LANTDIV) and the Marine Corps Base (MCB) Camp Lejeune. Field operations are being headed by DE&S, with support from Baker Environmental, OHM Remediation Services and International Technology (IT) Corp. The surfactant flood has been designed primarily by Dr. Gary Pope of the Department of Petroleum and Geosystems Engineering at UT, with support from Dr. Jeff Harwell of the Department of Chemical Engineering at OU. Surfactant treatment and recycling is being performed collaboratively by Dr. Leland Vane of EPA, NRMRL, in Cincinnati, and Dr. Edwin Tucker of the Chemistry and Biochemistry Department at OU. DE&S, in partnership with Baker Environmental, will conduct the surfactant flood and post-surfactant flood PITT. IT Corp. will provide field assistance for pervaporation during the surfactant flood. OHM Remediation Services will provide final treatment and disposal of wastewater from the demonstration.

The SEAR demonstration results will be evaluated to determine the effectiveness of SEAR for remediating DNAPL contaminated sites. An assessment of technical and cost issues

associated with SEAR implementation, including the feasibility and benefit of incorporating a surfactant recycling process, will be performed.

This work plan details the activities to be undertaken to perform the SEAR demonstration at Site 88. Field operations are scheduled to begin with system setup in March 1999. The surfactant flood and PITT2 are scheduled for completion in July 1999. Attached Figure 4 is a project timeline showing the different phases of the work and the estimated times of completion.

Reference

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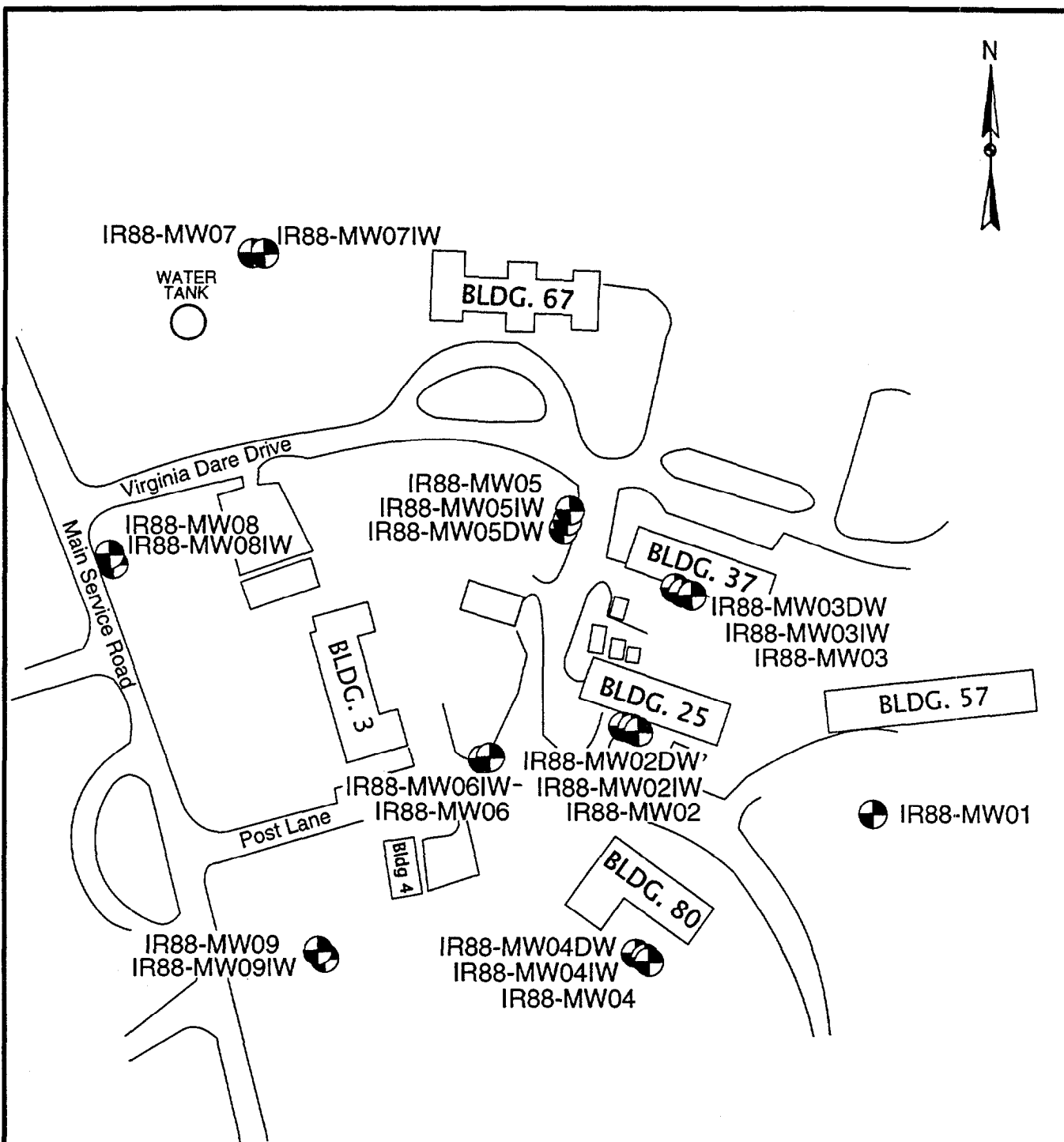
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IR88-MW05



Permanent Monitoring Well

Note: Well Locations are Approximate

DATE: 1/22/99

REF: TDN 30199999

FILE: PERMWEL.XAR

Permanent Monitor Well Locations at Site 88

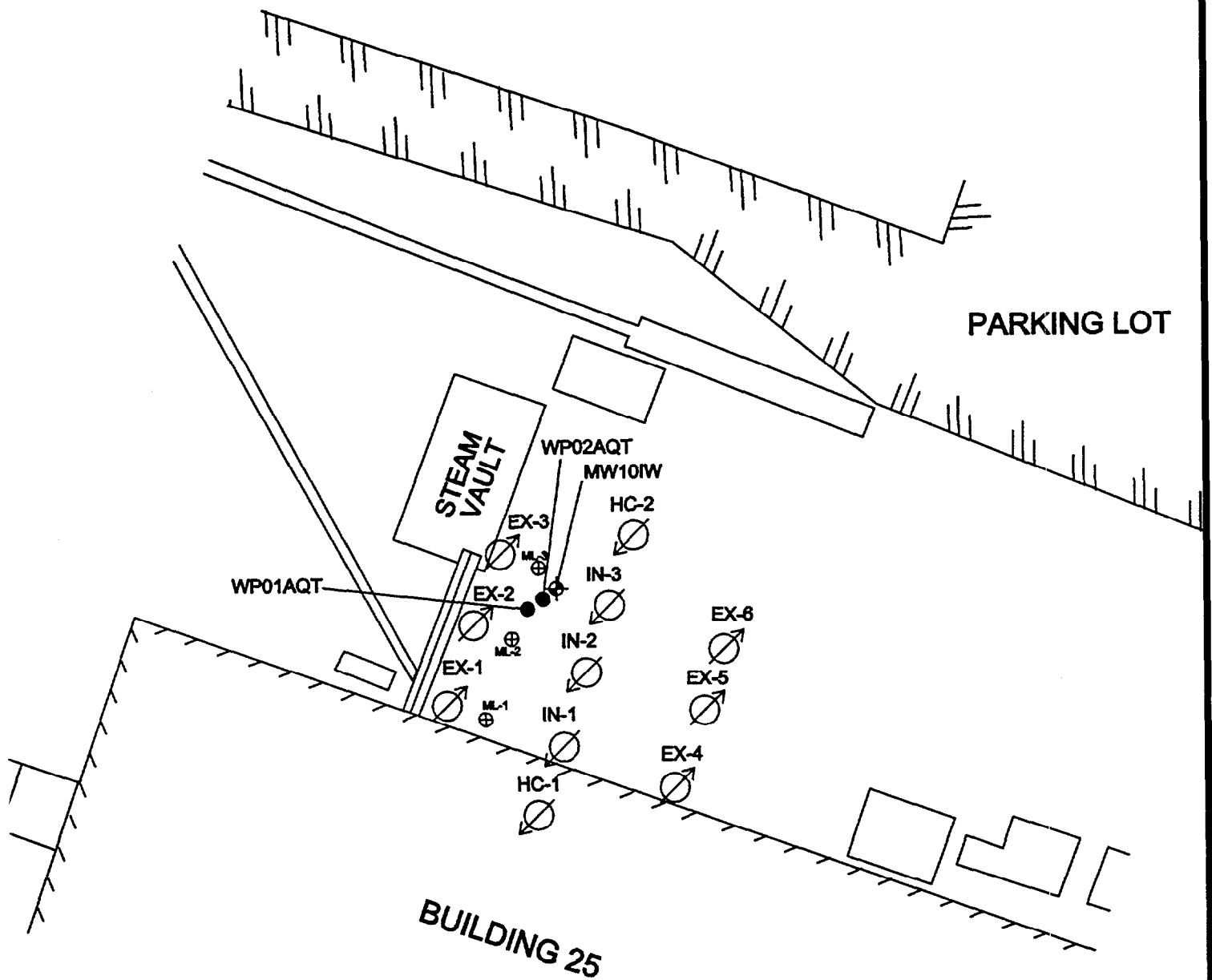
Wells Installed During the Remedial Investigation

(Modified from Baker Environmental, Inc.)



MCB Camp Lejeune, NC

Figure 2



LEGEND

- EX-1
⊗ EXTRACTION WELL
- IN-1
⊗ INJECTION WELL/
HYDRAULIC CONTROL
WELL
- ML-3
⊕ MULTILEVEL SAMPLER
- AQUITARD MONITOR
WELL POINT
- ⊕ UPPER CASTLE HAYNE
MONITOR WELL

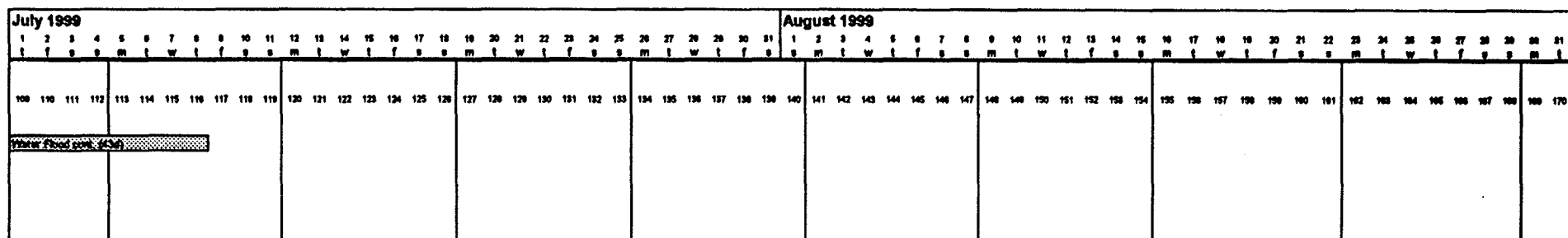
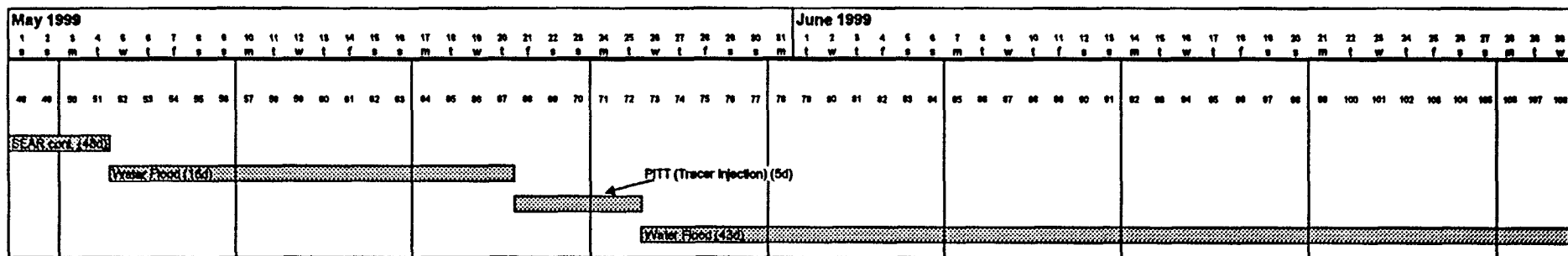
NOTE: THE LOCATIONS OF THE
WELLS ARE APPROXIMATE.

DATE: 1/22/99
REF: TDN 307
File: Locmap2.dwg

**Duke Engineering
& Services**
A Duke Energy Company

Location of the
Demonstration Well Array

Figure 3

[illegible]

Project Timeline for SEAR Demonstration and PITT at Site 88, MCB Camp Lejeune, North Carolina	Figure 4
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CONDEA VISTA COMPANY



permeant product
or experimental use only

MATERIAL SAFETY DATA SHEET

PRODUCT IDENTIFICATION

MANUFACTURING SITE	CONDEA VISTA Research and Development		
ADDRESS	12024 Vista Parke drive, Austin, TX 78726		
TRADE NAME	Alfoterra®145-4PO Sulfate		
SYNONYMS	Branched alcohol propoxylate sulfate, sodium salt Isalchem®145-4PO Sulfate		
CAS NUMBER	Not available		
TELEPHONE NO.	281-588-3059	EMERGENCY TELEPHONE NO.	512-331-2500

COMPONENT INFORMATION

This product contains:

- Unulfonated propoxylated materials (≈2-4%) and branched alcohol propoxylate sulfate, sodium salt (≈25-35%) and water (≈ 60-73 %)

(This product is not listed on the TSCA inventory)

PHYSICAL DATA

BOILING POINT (°F)	Not available	SPECIFIC GRAVITY (H ₂ O=1)	Not determined
VAPOR PRESSURE	Not determined	MELTING POINT	Not determined
SOLUBILITY IN WATER	Miscible	VAPOR DENSITY	Not available
APPEARANCE AND COLOR	Clear to pale yellow liquid, sweet odor.		

FIRE AND EXPLOSION DATA

FLASH POINT (TEST METHOD)	> 200°F (est.)	AUTOIGNITION TEMPERATURE	Not available	
FLAMMABILITY LIMITS (AIR (% VOL))	LOWER	Not available	UPPER	Not available
EXTINGUISHING MEDIA	Water spray, fog, or alcohol compatible foam is recommended.			
SPECIAL FIRE FIGHTING PROCEDURES	Cool exposed equipment with water spray until well after fire is out. Self-contained breathing apparatus (SCBA) and structural firefighter's protective clothing will provide limited protection.			
UNUSUAL FIRE AND EXPLOSION HAZARD	None			

Alfocem®145-4PO Sulfate

5. HEALTH AND ENVIRONMENTAL HAZARD INFORMATION**FIRST AID**

EYES: Flush eyes with large amounts of water for at least 15 minutes. Seek medical aid.

SKIN: Remove contaminated clothing. Wash with soap and water. If irritation persists, seek medical attention.

INHALATION: Remove to fresh air. If not breathing, give artificial respiration and seek medical attention immediately. Oxygen should only be administered by trained personnel.

INGESTION: If swallowed, call a physician immediately. ONLY induce vomiting at the instruction of a physician. Never give anything by mouth to an unconscious person.

NATURE OF HAZARD

EYE: Irritation may occur with exposure to concentrated vapors or contact with product. May cause corneal inflammation.

SKIN: Repeated or prolonged contact can cause reddening and scaling of the skin (dermatitis).

INHALATION: This material is a negligible hazard due to its low volatility. If vapor is present in high concentrations, irritation to upper respiratory tract may occur.

INGESTION: Low order of toxicity. No hazard by this route in normal use. Ingestion of large amounts may be irritating to gastrointestinal tract.

EXPOSURE LIMITS

None established for this product.

TOXICITY DATA**HEALTH EFFECTS STUDIES**

No health effects studies have been conducted on this product. However, results of toxicity studies conducted on similar materials are provided below.

Oral LD₅₀ (rat) = >5 g/kg

Rabbit eye irritation (Draize score) = approx. 12-21 (scale of 0-100)

4-hr Skin irritation (rabbit) = approx. 4 (scale of 0-8)

Xerox® 145-4PO Sulfate

HEALTH AND ENVIRONMENTAL HAZARD INFORMATION (Continued)**ECOTOXICOLOGICAL STUDIES:**

3-branch C1415 alcohol propoxylate sulfate (4 mole PO) - A Microtox screening test showed an EC_{50} of >800 mg/L, which indicates minimal ecotoxicity. In comparison, the aquatic toxicity to algae, invertebrates and fish of analogous alcohol ether sulfates (AES) containing C12 to C15 linear alcohol and 3-5 moles of ethylene oxide show EC_{50} values from 1.5 to 68 mg/L. Since it is known that branching in the alcohol and in the propylene oxide reduce aquatic toxicity, the lower ecotoxicity of this material is to be expected.

ENVIRONMENTAL FATE INFORMATION

Based on the literature, it is reasonable to assume that this product will undergo complete but slower biodegradation than an analogous AES made from linear alcohols and ethoxylates.

SPECIAL PRECAUTIONS: AVOID EYE CONTACT**REACTIVITY DATA**

CONDITIONS CONTRIBUTING TO INSTABILITY: stable

INCOMPATIBILITY: Can react with strong oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS: Oxides of sulfur, carbon dioxide, and carbon monoxide

CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION: Should not occur.

SPILL OR LEAK PROCEDURES

Eliminate all sources of ignition. Contain the spill if possible. Dispose of only in accordance with local, state, and federal regulations.

WASTE CLASSIFICATION: If discarded in its purchased form, this product is not a RCRA hazardous waste. Re-evaluation of the product may be required by the user at the time of disposal, since the product may undergo chemical transformations, and mixtures may change the classification.

SPECIAL PROTECTION INFORMATION**VENTILATION RECOMMENDATIONS**

Mechanical ventilation is recommended if handling in an enclosed space or at elevated temperatures. Trace amounts of ethylene oxide and dioxane may be present in the product and could accumulate in vapor spaces of storage or transport vessels.

Alkoxyls 145-4PO Sulfate

8. SPECIAL PROTECTION INFORMATION (Continued)

SPECIFIC PERSONAL PROTECTIVE EQUIPMENT

EYES: When contact with liquid is possible, use a face shield and chemical goggles. Otherwise use safety glasses or goggles.

SKIN: Full protective clothing, boots, and gloves when contact with liquid is possible.

RESPIRATORY PROTECTION: NIOSH/MSHA-approved vapor air-purifying respirator, self-contained breathing apparatus, or air-supplied respirators dependent on concentration.

9. STORAGE

ELECTROSTATIC ACCUMULATION HAZARD: Precautions should be taken to prevent electrostatic discharge.

USUAL SHIPPING CONTAINERS: plastic drums, glass containers, nalgene bottles

STORAGE/TRANSPORT TEMPERATURE: ambient

STORAGE/TRANSPORT PRESSURE: Ambient

THE ABOVE DATA IS BASED ON TEST AND EXPERIENCE WHICH CONDEA VISTA BELIEVES RELIABLE AND ARE SUPPLIED FOR INFORMATIONAL PURPOSES ONLY. THE PRODUCT DESCRIBED HEREIN IS SUPPLIED AS A SAMPLE ONLY, AND HAS NOT BEEN COMMERCIALIZED. CONDEA VISTA REQUESTS THAT CUSTOMERS INSPECT AND TEST OUR PRODUCTS BEFORE USE AND SATISFY THEMSELVES AS TO CONTENTS AND SUITABILITY. CONDEA VISTA DISCLAIMS ANY LIABILITY FOR DAMAGE OR INJURY WHICH RESULTS FROM THE USE OF THE ABOVE DATA AND NOTHING CONTAINED THEREIN SHALL CONSTITUTE A GUARANTEE, WARRANTY (INCLUDING WARRANTY OF MERCHANTABILITY) OR REPRESENTATION (INCLUDING FREEDOM FROM PATENT LIABILITY) BY CONDEA VISTA WITH RESPECT TO THE DATA, THE PRODUCT DESCRIBED, OR THEIR USE FOR ANY SPECIFIC PURPOSE, EVEN IF THAT PURPOSE IS KNOWN TO CONDEA VISTA.

Date created: 1/22/99
J:\PUB\EXPMSDS\alcohol propoxy sulfates\145-4po.doc

**Section 1 - Chemical Product and Company Identification****42****Product/Chemical Name:** Isopropyl Alcohol**Chemical Formula:** $(\text{CH}_3)_2\text{CHOH}$ **CAS No.:** 67-63-0**Synonyms:** Dimethyl carbinol, 2-hydroxypropane, IPA, Isohol, Lutosol, isopropanol, Petrohol, 2-propanol, sec-propyl alcohol, rubbing alcohol, Spectrar.**Derivation:** Treating propylene with sulfuric acid and then hydrolyzing or direct hydration of propylene using superheated steam. Most commonly available as rubbing alcohol (70% IPA).**General Use:** As a solvent for gums, shellac, and essential oils, chemical intermediate, dehydrating agent, vehicle for germicidal compounds, de-icing agent for liquid fuels; for denaturing ethyl alcohol, preserving pathological specimens; in extraction of alkaloids, quick-drying inks and oils, and an ingredient of skin lotions, cosmetics, window cleaner, liquid soaps, and pharmaceuticals.**Vendors:** Consult the latest *Chemical Week Buyers' Guide*. (73)**Section 2 - Composition / Information on Ingredients**

Isopropyl alcohol, 100% vol. Most commonly sold as 70% isopropyl alcohol (rubbing alcohol).

OSHA PELs8-hr TWA: 400 ppm (980 mg/m³)STEL: 500 ppm (1225 mg/m³) ***ACGIH TLVs**TWA: 400 ppm (983 mg/m³)STEL: 500 ppm (1230 mg/m³)**NIOSH REL**10-hr TWA: 400 ppm (980 mg/m³)STEL: 500 ppm (1225 mg/m³)**IDLH Level**

12,000 ppm

DFG (Germany) MAKTWA: 400 ppm (980 mg/m³)

Category II: Substances with systemic effects

Half-life: < 2 hr

Peak Exposure Limit: 800 ppm, 30 min. average value, 4/shift

* Vacated 1989 Final Rule Limits

Section 3 - Hazards Identification**☆☆☆☆☆ Emergency Overview ☆☆☆☆☆**

Isopropyl alcohol is a highly flammable, volatile liquid. It is considered more toxic than ethyl alcohol, but less toxic than methyl alcohol. Inhalation can cause irritation of the eyes and respiratory tract and central nervous system depression at high concentrations. Repeated skin contact may cause dermatitis. Systemic toxicity appears to occur mostly in cases of heavy ingestion or inhalation. There is recent evidence that skin absorption may be more likely to cause systemic effects than previously thought.

Potential Health Effects**Primary Entry Routes:** Inhalation, ingestion, skin contact/absorption.**Target Organs:** Eyes, skin, respiratory system.**Acute Effects****Inhalation:** Vapor inhalation is irritating to the respiratory tract and can cause central nervous system depression at high concentrations. Volunteers exposed to 400 ppm for 3 to 5 min experienced mild eye and respiratory irritation. At 800 ppm, irritation was not severe, but most people found the air uncomfortable to breathe.**Eye:** Exposure to the vapor or direct contact with the liquid causes irritation and possible corneal burns.**Skin:** Some irritation may occur after prolonged exposure.**Ingestion:** Accidental ingestions have provided the most information on isopropyl alcohol toxicity. Symptoms include nausea and vomiting, headache, facial flushing, dizziness, lowered blood pressure, mental depression, hallucinations and distorted perceptions, difficulty breathing, respiratory depression, stupor, unconsciousness, and coma. Kidney insufficiency including oliguria (reduced urine excretion), anuria (absent urine excretion), nitrogen retention, and edema (fluid build-up in tissues) may occur. One post-mortem examination in a case of heavy ingestion showed extensive hemorrhagic tracheobronchitis, bronchopneumonia, and hemorrhagic pulmonary edema. Death can occur in 24 to 36 h post-ingestion due to respiratory paralysis.**Carcinogenicity:** NTP and OSHA do not list isopropyl alcohol as a carcinogen. The IARC has studied IPA and has classified it as Class-3 (unclassifiable, inadequate human and animal evidence). There appears to be an association between the manufacture (strong acid process, rather than the alcohol itself) of isopropanol and paranasal cancer, but this may be due to the diisopropyl sulfate or isopropyl oil by-products.**Medical Conditions Aggravated by Long-Term Exposure:** Dermatitis or respiratory or kidney disorders.**Chronic Effects:** Repeated skin contact can cause drying of skin and delayed hypersensitivity reactions in some individuals.**Wilson
Risk
Scale**R 1
I 2
S 2*
K 3*Skin
absorption**HMIS**H 1
F 3
R 0**PPE†**

†Sec. 8

Other: Isopropyl alcohol is oxidized in the body to acetone where it is excreted by the lungs or kidneys. Some acetone may be further metabolized to acetate, formate, and finally carbon dioxide. Probable oral lethal dose is 240 mL.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water to dilute. Vomiting may be contraindicated because of the rapid onset of central nervous system depression. Gastric lavage is preferred.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Diagnostic test: acetone in urine.

Section 5 - Fire Fighting Measures

Flash Point: 53 °F (12 °C)

Flash Point Method: CC

Burning Rate: 2.3 mm/min.

Autoignition Temperature: 750°F (399°C)

LEL: 2 % v/v

UEL: 12.7 % v/v at 200 °F

Flammability Classification: Class 1B Flammable Liquid

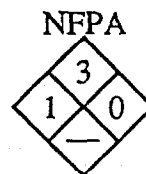
Extinguishing Media: Carbon dioxide, dry chemical, water *spray* (solid streams can spread fire), alcohol-resistant foam, or fog.

Unusual Fire or Explosion Hazards: Container may explode in heat of fire. Vapors may travel to an ignition source and flash back. Isopropyl alcohol poses an explosion hazard indoors, outdoors, and in sewers.

Hazardous Combustion Products: Carbon oxides and acrid smoke.

Fire-Fighting Instructions: If possible without risk, move container from fire area. Apply cooling water to container side until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw and let fire burn. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire. *Do not* release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides only limited protection.



Section 6 - Accidental Release Measures

Spill/Leak Procedures: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources. Cleanup personnel should protect against vapor inhalation and skin/eye contact. Water spray may reduce vapor, but may not prevent ignition in closed spaces.

Small Spills: Take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers.

Large Spills

Containment: For large spills, dike far ahead of liquid spill for later disposal. Do not release into sewers or waterways.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use non-sparking tools to open containers.

Storage Requirements: Store in a cool, dry, well-ventilated area away from heat, ignition sources, and incompatibles (Sec 10).

Install electrical equipment of Class 1, Group D.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically ground and bond all equipment used with and around IPA.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne levels below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾

Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the skin, kidneys, and respiratory system. Be extra cautious when using IPA concurrently with carbon tetrachloride because animal studies have shown it enhances carbon tetrachloride's toxicity.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Nitrile rubber (breakthrough time > 8 hr), Neoprene and Teflon (breakthrough time > 4 hr) are suitable materials for PPE. Do not use PVA, PVC or natural rubber (breakthrough time < 1 hr). Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 1000 ppm, use any powered, air purifying respirator with organic vapor cartridges or any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s). For < 10,000 ppm, use any supplied-air respirator (SAR) operated in continuous-flow mode. For < 12,000 ppm, use any air-purifying, full facepiece respirator (gas mask) with a chin-style, front-or back-mounted organic vapor canister or any SCBA or SAR with a full facepiece. For emergency or entrance into unknown concentrations, use any SCBA or SAR (with auxiliary SCBA) with a full facepiece and operated in pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove isopropyl alcohol from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using isopropyl alcohol, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Liquid

Appearance and Odor: Colorless with a slight odor and bitter taste.

Odor Threshold: 22 ppm*

Vapor Pressure: 44 mm Hg at 25 °F (77 °C)

Saturated Vapor Density: (Air = 1.2 kg/m³, 0.075 lb/ft³):

1.274 kg/m³ or 0.080 lb/ft³

Formula Weight: 60.09

Density (H₂O=1, at 4 °C): 0.78505 at 68°F (20 °C)

Water Solubility: > 10 %

Ionization Potential: 10.10 eV

Other Solubilities: Soluble in alcohol, ether, chloroform, and benzene. Insoluble in salt solutions.

Boiling Point: 180.5 °F (82.5 °C)

Freezing Point: -129.1 °F (-89.5 °C)

Viscosity: 2.1 cP at 77 °F (25 °C)

Refraction Index: 1.375 at 68 °F (20 °C)

Surface Tension: 20.8 dyne/cm at 77 °F (25 °C)

Critical Temperature: 455 °F (235 °C)

Critical Pressure: 47 atm

Octanol/Water Partition Coefficient: log Kow = 0.05

* References range from 1 to as high as 610 ppm.

Section 10 - Stability and Reactivity

Stability: Isopropyl alcohol is stable at room temperature in closed containers under normal storage and handling conditions.

Polymerization: Hazardous polymerization does not occur.

Chemical Incompatibilities: Include acetaldehyde, chlorine, ethylene oxide, acids and isocyanates, hydrogen + palladium, nitroform, oleum, phosgene, potassium *t*-butoxide, oxygen (forms unstable peroxides), trinitromethane, barium perchlorate, tetrafluoroborate, chromium trioxide, sodium dichromate + sulfuric acid, aluminum, aluminum triisopropoxide, and oxidizers.

Will attack some forms of plastic, rubber, and coatings.

Conditions to Avoid: Exposure to heat, ignition sources, and incompatibles.

Hazardous Decomposition Products: Thermal oxidative decomposition of isopropyl alcohol can produce carbon oxides and acrid smoke.

Section 11 - Toxicological Information

Toxicity Data:*

Eye Effects:

Rabbit, eye: 100 mg caused severe irritation.

Skin Effects:

Rabbit, skin: 500 mg caused mild irritation.

Reproductive:

Rat, inhalation: 3500 ppm/7 hr given from 1 to 19 days of pregnancy caused fetotoxicity.

Acute Oral Effects:

Human, oral, TD_{Lo}: 223 mg/kg caused hallucinations, distorted perceptions, lowered blood pressure, and a change in pulse rate.

Human, oral, LD_{Lo}: 3570 mg/kg caused coma, respiratory depression, nausea, and vomiting.

Rat, oral, LD₅₀: 5045 mg/kg caused a change in righting reflex, and somnolence (general depressed activity).

* See NIOSH, RTECS (NT8050000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Guppies (*Poecilia reticulata*) LC₅₀ = 7,060 ppm/7 days; fathead minnow (*Pimephales promelas*) LC₅₀ = 11,830 mg/L/1 hr. BOD = 133 %/5 days.

Environmental Degradation: On soil, IPA will volatilize or leach into groundwater. Biodegradation is possible but rates are not found in available literature. It will volatilize (est. half-life = 5.4 days) or biodegrade in water. It is not expected to bioconcentrate in fish. In the air, it reacts with photochemically produced hydroxyl radicals with a half-life of one to several days. Because it is soluble, removal by rain, snow or other precipitation is possible.

Section 13 - Disposal Considerations

Disposal: Microbial degradation is possible by oxidizing isopropyl alcohol to acetone by members of the genus *Desulfovibrio*. Spray waste into incinerator (permit-approved facilities only) equipped with an afterburner and scrubber. Isopropyl alcohol can be settled out of water spills by salting with sodium chloride. Note: Salt may harm aquatic life, so weigh the benefits against possible harm before application. Contact your supplier or a licensed contractor for detailed recommendations. ~~How~~ applicable Federal, state, and local regulations.

Container Cleaning and Disposal: Triple rinse containers.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Isopropanol or isopropyl alcohol

Shipping Symbols: -

Hazard Class: 3

ID No.: UN1219

Packing Group: II

Label: Flammable Liquid

Special Provisions (172.102): T1

Packaging Authorizations

a) Exceptions: 173.150

b) Non-bulk Packaging: 173.202

c) Bulk Packaging: 173.242

Quantity Limitations

a) Passenger, Aircraft, or Railcar: 5 L

b) Cargo Aircraft Only: 60 L

Vessel Stowage Requirements

a) Vessel Stowage: B

b) Other: -

Section 15 - Regulatory Information

EPA Regulations:

Listed as a RCRA Hazardous Waste Number (40 CFR 261.21)

RCRA Hazardous Waste Classification (40 CFR 261.21): Characteristic of Ignitability

Listed (Unlisted Hazardous Waste, Characteristic of Ignitability) as a CERCLA Hazardous Substance (40 CFR 302.4) per RCRA, Sec. 3001

CERCLA Reportable Quantity (RQ), 100 lb (45.4 kg)

SARA 311/312 Codes: 1, 2, 3

Listed as a SARA Toxic Chemical (40 CFR 372.65); *only persons who manufacture by the strong acid process are subject; no supplier notification.*

SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

Section 16 - Other Information

References: 73, 103, 124, 126, 127, 132, 136, 139, 148, 153, 159, 164, 167, 168, 176, 187

Prepared By M Gannon, BA

Industrial Hygiene Review PA Roy, MPH, CIH

Medical Review T Thoburn, MD, MPH

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Potassium Bromide

**** MATERIAL SAFETY DATA SHEET ****

Potassium Bromide
19280

**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name: Potassium Bromide

Catalog Numbers:

AC424070030, S80134, S80134-1, P205 3, P205 500, P205-3, P205-500, P2053,
P205500, P227 25, P227-25, P22725, S801341

Synonyms:

Hydrobromic Acid Potassium Salt; Bromide Salt of Potassium.

Company Identification: Fisher Scientific

1 Reagent Lane
Fairlawn, NJ 07410

For information, call: 201-796-7100

Emergency Number: 201-796-7100

For CHEMTREC assistance, call: 800-424-9300

For International CHEMTREC assistance, call: 703-527-3887

**** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

+-----+-----+-----+-----+			
-+	CAS#	Chemical Name	% EINECS#
+-----+-----+-----+-----+			
-	7758-02-3	Potassium bromide	100 231-830-3
+-----+-----+-----+-----+			
-+			

**** SECTION 3 - HAZARDS IDENTIFICATION ****

EMERGENCY OVERVIEW

Appearance: colorless to white.

Caution! May cause respiratory tract irritation. May cause eye and skin irritation. May cause digestive tract irritation with nausea, vomiting, and diarrhea.

Target Organs: Central nervous system.

Potential Health Effects

Eye:

May cause eye irritation.

Skin:

May cause skin irritation. Causes symptoms similar to those of inhalation.

Ingestion:

May cause central nervous system depression, characterized by excitement, followed by headache, dizziness, drowsiness, and nausea. Advanced stages may cause collapse, unconsciousness, coma and possible death due to respiratory failure. May cause effects similar to those of acute inhalation.

Inhalation:

May cause effects similar to those described for ingestion:

Chronic:

Chronic ingestion may cause effects similar to those of acute ingestion.

**** SECTION 4 - FIRST AID MEASURES ****

Eyes:

Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Get medical aid.

Skin:

Get medical aid. Flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes.

Ingestion:

If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid immediately.

Inhalation:

Remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.

Notes to Physician:

Treat symptomatically and supportively.

**** SECTION 5 - FIRE FIGHTING MEASURES ****

General Information:

As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Substance is noncombustible.

Extinguishing Media:

Use extinguishing media most appropriate for the surrounding fire.

Autoignition Temperature: Not applicable.

Flash Point: Not applicable.

NFPA Rating: Not published.

Explosion Limits, Lower: Not available.

Upper: Not available.

**** SECTION 6 - ACCIDENTAL RELEASE MEASURES ****

General Information: Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks:

Sweep up, then place into a suitable container for disposal.

**** SECTION 7 - HANDLING and STORAGE ****

Handling:

Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Use with adequate ventilation. Avoid contact with eyes. Do not ingest or inhale.

Storage:

Store in a cool, dry place.

**** SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION ****

Engineering Controls:

Use adequate ventilation to keep airborne concentrations low.

Exposure Limits

-----+-----+-----+-----			
Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
-----+-----+-----+-----			
Potassium bromide	none listed	none listed	none listed
-----+-----+-----+-----			

OSHA Vacated PELs:

Potassium bromide:

No OSHA Vacated PELs are listed for this chemical.

Personal Protective Equipment

Eyes:

Wear safety glasses and chemical goggles if splashing is possible.

Skin:

Wear appropriate protective gloves and clothing to prevent skin exposure.

Clothing:

Wear appropriate protective clothing to minimize contact with skin.

Respirators:

Follow the OSHA respirator regulations found in 29CFR 1910.134. Always use a NIOSH-approved respirator when necessary.

**** SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES ****

Physical State:	Solid
Appearance:	colorless to white
Odor:	Odorless
pH:	Neutral in solution.
Vapor Pressure:	Not applicable.
Vapor Density:	Not applicable.
Evaporation Rate:	Not applicable.
Viscosity:	Not applicable.
Boiling Point:	1435 deg C
Freezing/Melting Point:	734 deg C
Decomposition Temperature:	Not available.
Solubility:	Soluble in water.
Specific Gravity/Density:	2.75

Molecular Formula: KBr
Molecular Weight: 119.0023

**** SECTION 10 - STABILITY AND REACTIVITY ****

Chemical Stability:

Stable under normal temperatures and pressures.

Conditions to Avoid:

Incompatible materials.

Incompatibilities with Other Materials:

Strong oxidizing agents; strong acids; heavy metal salts Reacts violently with bromine trifluoride.

Hazardous Decomposition Products:

Hydrogen bromide, oxides of potassium.

Hazardous Polymerization: Will not occur.

**** SECTION 11 - TOXICOLOGICAL INFORMATION ****

RTECS#:

CAS# 7758-02-3: TS7650000

LD50/LC50:

Not available.

Carcinogenicity:

Potassium bromide -

Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.

Epidemiology:

No data available.

Teratogenicity:

No data available.

Reproductive Effects:

No data available.

Neurotoxicity:

No data available.

Mutagenicity:

No data available.

Other Studies:

No data available.

**** SECTION 12 - ECOLOGICAL INFORMATION ****

Ecotoxicity:

Not available.

Environmental Fate:

Not available.

Physical/Chemical:

Not available.

Other:

Not available.

**** SECTION 13 - DISPOSAL CONSIDERATIONS ****

Dispose of in a manner consistent with federal, state, and local regulations.

RCRA D-Series Maximum Concentration of Contaminants: Not listed.

RCRA D-Series Chronic Toxicity Reference Levels: Not listed.

RCRA F-Series: Not listed.

RCRA P-Series: Not listed.

RCRA U-Series: Not listed.

Not listed as a material banned from land disposal according to RCRA.

**** SECTION 14 - TRANSPORT INFORMATION ****

US DOT

No information available

IMO

No information available.

IATA

No information available.

RID/ADR

No information available.

Canadian TDG

No information available.

**** SECTION 15 - REGULATORY INFORMATION ****

US FEDERAL

TSCA

CAS# 7758-02-3 is listed on the TSCA inventory.

Health & Safety Reporting List

None of the chemicals are on the Health & Safety Reporting List.

Chemical Test Rules

None of the chemicals in this product are under a Chemical Test Rule

Section 12b

None of the chemicals are listed under TSCA Section 12b.

TSCA Significant New Use Rule

None of the chemicals in this material have a SNUR under TSCA.

SARA

Section 302 (RQ)

None of the chemicals in this material have an RQ.

Section 302 (TPQ)

None of the chemicals in this product have a TPQ.

SARA Codes

CAS # 7758-02-3: acute, chronic.

Section 313

No chemicals are reportable under Section 313.

Clean Air Act:

This material does not contain any hazardous air pollutants.

This material does not contain any Class 1 Ozone depletors.

This material does not contain any Class 2 Ozone depletors.

Clean Water Act:

None of the chemicals in this product are listed as Hazardous Substances under the CWA.

None of the chemicals in this product are listed as Priority Pollutants under the CWA.

None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

OSHA:

None of the chemicals in this product are considered highly hazardou

s

by OSHA.

STATE

Not present on state lists from CA, PA, MN, MA, FL, or NJ.

California No Significant Risk Level:

None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols: Not available.

Risk Phrases:

Safety Phrases:

S 24/25 Avoid contact with skin and eyes.

S 26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.

S 28 After contact with skin, wash immediately with plenty of ... (to be specified by the manufacturer).

S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

WGK (Water Danger/Protection)

CAS# 7758-02-3: 1

Canada

CAS# 7758-02-3 is listed on Canada's DSL/NDSL List.

This product has a WHMIS classification of D2B.

CAS# 7758-02-3 is listed on Canada's Ingredient Disclosure List.

Exposure Limits

**** SECTION 16 - ADDITIONAL INFORMATION ****

MSDS Creation Date: 3/15/1995 Revision #4 Date: 9/02/1997

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to

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MATERIAL SAFETY DATA SHEET

1-Propanol, 99+%

96449

**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name: 1-Propanol, 99+%

Propyl alcohol

Company Identification: Acros Organics N.V.
One Reagent Lane
Fairlawn, NJ 07410

For information in North America, call: 800-ACROS-01

For emergencies in the US, call CHEMTREC: 800-424-9300

For emergencies in the US, call CHEMTREC: 800-424-9300

**** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

CAS#	Chemical Name	%	EINECS#
71-23-8	n-Propyl alcohol	100	200-746-9

Hazard Symbols: F

Risk Phrases: 11

**** SECTION 3 - HAZARDS IDENTIFICATION ****

EMERGENCY OVERVIEW

Appearance: clear, colorless. Flash Point: 59 deg F.

Warning! Flammable liquid. May cause central nervous system depression. May cause eye and skin irritation. May cause respiratory and digestive tract irritation. May cause dermatitis.

Target Organs: Kidneys, central nervous system, liver.

Potential Health Effects

Eye:

May cause moderate eye irritation. May result in corneal injury.

Skin:

May cause moderate skin irritation. Prolonged and/or repeated contact may cause defatting of the skin and dermatitis.

Ingestion:

May cause gastrointestinal irritation with nausea, vomiting and diarrhea. May cause central nervous system depression, characterized by excitement, followed by headache, dizziness, drowsiness, and nausea. Advanced stages may cause collapse, unconsciousness, coma and possible death due to respiratory failure.

Inhalation:

Inhalation of vapor may cause respiratory tract irritation. May cause effects similar to those described for ingestion.

Chronic:

Prolonged or repeated skin contact may cause defatting and dermatitis.

**** SECTION 4 - FIRST AID MEASURES ****

Eyes:

Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Get medical aid.

Skin:

Get medical aid. Flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes.

Ingestion:

Do NOT induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid.

Inhalation:

Remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.

Notes to Physician:

Treat symptomatically and supportively.

**** SECTION 5 - FIRE FIGHTING MEASURES ****

General Information:

Containers can build up pressure if exposed to heat and/or fire. As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Combustion generates toxic fumes. During a fire,

irritating and highly toxic gases may be generated by thermal decomposition or combustion. Flammable Liquid. Can release vapors that form explosive mixtures at temperatures above the flashpoint.

Extinguishing Media:

Use water spray to cool fire-exposed containers. Use dry chemical, carbon dioxide, or alcohol-resistant foam.

Autoignition Temperature: 824 deg F (440.00 deg C)

Flash Point: 59 deg F (15.00 deg C)

NFPA Rating: health-1; flammability-3; reactivity-0

Explosion Limits, Lower: 2.1%

Upper: 13.5%

**** SECTION 6 - ACCIDENTAL RELEASE MEASURES ****

General Information: Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks:

Absorb spill with inert material, (e.g., dry sand or earth), then place into a chemical waste container. Remove all sources of ignition. Provide ventilation.

**** SECTION 7 - HANDLING and STORAGE ****

Handling:

Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Use with adequate ventilation. Use spark-proof tools and explosion proof equipment. Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Do not get on skin or in eyes. Do not ingest or inhale. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose empty containers to heat, sparks or open flames.

Storage:

Keep away from heat, sparks, and flame. Do not store near combustible materials. Store in a cool, dry place. Store in a tightly closed container. Keep from contact with oxidizing materials.

**** SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION ****

Engineering Controls:

Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.

Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs

n-Propyl alcohol	200 ppm ; 492	200 ppm TWA; 500	200 ppm TWA; 500
	mg/m3; 250 ppm	mg/m3 TWA; 250	mg/m3 TWA
	STEL; 614 mg/m3	ppm STEL; 625	
	STEL	mg/m3 STEL	

OSHA Vacated PELs:

n-Propyl alcohol:

200 ppm TWA; 500 mg/m3 TWA; 250 ppm STEL; 625 mg/m3 STEL

Personal Protective Equipment

Eyes:

Wear safety glasses and chemical goggles if splashing is possible.

Skin:

Wear appropriate protective gloves to prevent skin exposure.

Clothing:

Wear appropriate protective clothing to minimize contact with skin.

Respirators:

A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements must be followed whenever workplace conditions warrant a respirator's use.

**** SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES ****

Physical State: Liquid
 Appearance: clear, colorless
 Odor: Alcohol-like odor.
 pH: Not available.
 Vapor Pressure: 14.3 mm Hg @ 20
 Vapor Density: 2.07
 Evaporation Rate: Not available.
 Viscosity: 2.2 mPa s 20 C
 Boiling Point: 97.19 deg C
 Freezing/Melting Point: -127 deg C
 Decomposition Temperature: Not available.
 Solubility: Completely soluble in water.
 Specific Gravity/Density: 0.8044
 Molecular Formula: CH₃CH₂CH₂OH
 Molecular Weight: 60.0554

**** SECTION 10 - STABILITY AND REACTIVITY ****

Chemical Stability:

Stable under normal temperatures and pressures.

Conditions to Avoid:

Incompatible materials.

Incompatibilities with Other Materials:

Acid chlorides, acid anhydrides, oxidizing agents, potassium tert-butoxide.

Hazardous Decomposition Products:

Carbon monoxide, carbon dioxide.

Hazardous Polymerization: Will not occur.

**** SECTION 11 - TOXICOLOGICAL INFORMATION ****

RTECS#:

CAS# 71-23-8: UH8225000

LD50/LC50:

CAS# 71-23-8: Inhalation, mouse: LC50 = 48 gm/m³; Oral, mouse: LD50 = 6800 mg/kg; Oral, rabbit: LD50 = 2825 mg/kg; Oral, rat: LD50 = 1870 mg/kg; Skin, rabbit: LD50 = 4060 mg/kg.

Carcinogenicity:

n-Propyl alcohol -

Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.

Epidemiology:

Oral rat TDLo = 50 gm/kg/81 weeks. 1-Propanol caused liver tumors and leukemia according to RTECs criteria.

Teratogenicity:

No data available.

Reproductive Effects:

An exposure of 7000 ppm/7 hours caused a reduction in fertility in male rats and caused fetotoxic effects. A dose of 10000 ppm/7 hours caused musculoskeletal abnormalities and post-implantation mortality.

Neurotoxicity:

No data available.

Mutagenicity:

No data available.

Other Studies:

No data available.

**** SECTION 12 - ECOLOGICAL INFORMATION ****

Ecotoxicity:

Not available.

Environmental Fate:

Not available.

Physical/Chemical:

Not available.

Other:

Not available.

**** SECTION 13 - DISPOSAL CONSIDERATIONS ****

Dispose of in a manner consistent with federal, state, and local regulations.

RCRA D-Series Maximum Concentration of Contaminants: Not listed.

RCRA D-Series Chronic Toxicity Reference Levels: Not listed.

RCRA F-Series: Not listed.

RCRA P-Series: Not listed.

RCRA U-Series: Not listed.

Not listed as a material banned from land disposal according to RCRA.

**** SECTION 14 - TRANSPORT INFORMATION ****

US DOT

Shipping Name: N-PROPANOL

Hazard Class: 3

UN Number: UN1274

Packing Group: II

IMO

Shipping Name: NORMAL-PROPANOL

Hazard Class: 3.2

UN Number: 1274

Packing Group: II

IATA

Shipping Name: N-PROPANOL

Hazard Class: 3

UN Number: 1274

Packing Group: II

RID/ADR

Shipping Name: N-PROPANOL

Dangerous Goods Code: 3(3B)

UN Number: 1274

Canadian TDG

Shipping Name: N-PROPANOL

Hazard Class: 3

UN Number: UN1274

Other Information: FLASHPOINT 15 C

**** SECTION 15 - REGULATORY INFORMATION ****

US FEDERAL

TSCA

CAS# 71-23-8 is listed on the TSCA inventory.

Health & Safety Reporting List

None of the chemicals are on the Health & Safety Reporting List.

Chemical Test Rules

None of the chemicals in this product are under a Chemical Test Rule.

Section 12b

None of the chemicals are listed under TSCA Section 12b.

TSCA Significant New Use Rule

None of the chemicals in this material have a SNUR under TSCA.

SARA

Section 302 (RQ)

None of the chemicals in this material have an RQ.

Section 302 (TPQ)

None of the chemicals in this product have a TPQ.

SARA Codes

CAS # 71-23-8: acute, flammable.

Section 313

No chemicals are reportable under Section 313.

Clean Air Act:

This material does not contain any hazardous air pollutants.

This material does not contain any Class 1 Ozone depleters.

This material does not contain any Class 2 Ozone depleters.

Clean Water Act:

None of the chemicals in this product are listed as Hazardous Substances under the CWA.

None of the chemicals in this product are listed as Priority Pollutants under the CWA.

None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

n-Propyl alcohol can be found on the following state right to know lists: California, New Jersey, Florida, Pennsylvania, Minnesota, Massachusetts.

California No Significant Risk Level:

None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols: F

Risk Phrases:

R 11 Highly flammable.

Safety Phrases:

S 16 Keep away from sources of ignition - No smoking.

S 7 Keep container tightly closed.

WGK (Water Danger/Protection)

CAS# 71-23-8: 1

Canada

CAS# 71-23-8 is listed on Canada's DSL/NDSL List.

This product does not have a WHMIS classification.

CAS# 71-23-8 is listed on Canada's Ingredient Disclosure List.

Exposure Limits

CAS# 71-23-8: OEL-AUSTRALIA:TWA 200 ppm (500 mg/m³);STEL 250 ppm;Skin. OEL-BELGIUM:TWA 200 ppm (492 mg/m³);STEL 250 ppm;Skin. OEL-CZECHOSLOVAKIA:TWA 500 mg/m³;STEL 1000 mg/m³. OEL-DENMARK:TWA 200 ppm (500 mg/m³);Skin. OEL-FINLAND:TWA 200 ppm (500 mg/m³);STEL 250 ppm;Skin. OEL-FRANCE:TWA 200 ppm (500 mg/m³). OEL-HUNGARY:TWA 100 mg/m³;STEL 200 mg/m³. OEL-POLAND:TWA 200 mg/m³. OEL-RUSSIA:STEL 10 mg/m³ 150 ppm (350 mg/m³);STEL 250 ppm (all isomers). OEL-SWITZERLAND:TWA 200 ppm (500 mg/m³);Skin JAN9. OEL-TURKEY:TWA 200 ppm (500 mg/m³). OEL-UNITED KINGDOM:TWA 200 ppm (500 mg/m³);STEL 250 ppm;Skin. OEL IN BULGARIA, COLOMBIA, JORDAN, KOREA check ACGIH TLV. OEL IN NEW ZEALAND, SINGAPORE, VIETNAM check ACGI TLV

**** SECTION 16 - ADDITIONAL INFORMATION ****

MSDS Creation Date: 2/28/1996 Revision #1 Date: 9/02/1997

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no way shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.

[Back](#) to product information.



MATERIAL SAFETY DATA SHEET

1-Heptanol, 98%
36897

**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name: 1-Heptanol, 98%

Heptyl alcohol

Company Identification: Acros Organics N.V.
One Reagent Lane
Fairlawn, NJ 07410

For information in North America, call: 800-ACROS-01
For emergencies in the US, call CHEMTREC: 800-424-9300
For emergencies in the US, call CHEMTREC: 800-424-9300

**** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

CAS#	Chemical Name	%	EINECS#
111-70-6	1-HEPTANOL		203-897-9

Hazard Symbols: XN
Risk Phrases: 21/22 36

**** SECTION 3 - HAZARDS IDENTIFICATION ****

EMERGENCY OVERVIEW

Not available.
Appearance: Not available. Flash Point: 73 deg C.
Not available.
Target Organs: None known.

Potential Health Effects

Eye:

Causes eye irritation. Causes redness and pain.

Skin:

Harmful if absorbed through the skin.

Ingestion:

Harmful if swallowed. May cause headache.

Inhalation:

May cause respiratory tract irritation. May cause drowsiness, unconsciousness, and central nervous system depression.

Chronic:

Not available.

**** SECTION 4 - FIRST AID MEASURES ****

Eyes:

Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Get medical aid.

Skin:

Get medical aid. Flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes.

Ingestion:

Do NOT induce vomiting. Get medical aid. Wash mouth out with water.

Inhalation:

Remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.

Notes to Physician:

Treat symptomatically and supportively.

**** SECTION 5 - FIRE FIGHTING MEASURES ****

General Information:

As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Will burn if involved in a fire. Combustible Liquid.

Extinguishing Media:

Do NOT use water directly on fire. Use water spray to cool fire-exposed containers. Use foam, dry chemical, or carbon dioxide.

Autoignition Temperature: 350 deg C (662.00 deg F)

Flash Point: 73 deg C (163.40 deg F)

NEPA Rating: Not published.

Explosion Limits, Lower: Not available.

Upper: Not available.

**** SECTION 6 - ACCIDENTAL RELEASE MEASURES ****

General Information: Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks:

Absorb spill with inert material, (e.g., dry sand or earth), then place into a chemical waste container.

**** SECTION 7 - HANDLING and STORAGE ****

Handling:

Avoid breathing dust, vapor, mist, or gas. Avoid contact with skin and eyes.

Storage:

Keep away from sources of ignition. Store in a cool, dry place. Store in a tightly closed container.

**** SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION ****

Engineering Controls:

Use adequate ventilation to keep airborne concentrations low.

Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
1-HEPTANOL	none listed	none listed	none listed

OSHA Vacated PELs:

1-HEPTANOL:

No OSHA Vacated PELs are listed for this chemical.

Personal Protective Equipment

Eyes:

Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133.

Skin:

Wear appropriate protective gloves to prevent skin exposure.

Clothing:

Wear appropriate protective clothing to prevent skin exposure.

Respirators:

Follow the OSHA respirator regulations found in 29CFR 1910.134. Always use a NIOSH-approved respirator when necessary.

**** SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES ****

Physical State: Liquid
Appearance: Not available.
Odor: Slight pleasant
pH: Not available.
Vapor Pressure: 0.5 mbar @ 20 deg C
Vapor Density: Not available.
Evaporation Rate: Not available.
Viscosity: Not available.
Boiling Point: 176 deg C @ 760.00mm Hg
Freezing/Melting Point: -35 deg C
Decomposition Temperature: Not available.
Solubility: soluble in ethanol, ether and usual orga
Specific Gravity/Density: .8220g/cm3
Molecular Formula: C7H16O
Molecular Weight: 116.20

**** SECTION 10 - STABILITY AND REACTIVITY ****

Chemical Stability:
Stable under normal temperatures and pressures.
Conditions to Avoid:
Incompatible materials.
Incompatibilities with Other Materials:
Strong oxidizing agents - strong acids - acid chlorides - acid anhydrides.
Hazardous Decomposition Products:
Carbon monoxide, carbon dioxide.
Hazardous Polymerization: Has not been reported.

**** SECTION 11 - TOXICOLOGICAL INFORMATION ****

RTECS#:
CAS# 111-70-6: MK0350000
LD50/LC50:
CAS# 111-70-6: Inhalation, mouse: LC50 = 6600 mg/m3/2H; Oral, mouse:
LD50 = 1500 mg/kg; Oral, rabbit: LD50 = 750 mg/kg; Oral, rat: LD50 =
500 mg/kg; Skin, rabbit: LD50 = 2 gm/kg.
Carcinogenicity:
1-HEPTANOL -
Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Epidemiology:
No data available.
Teratogenicity:
No data available.
Reproductive Effects:

No data available.
Neurotoxicity:
No data available.
Mutagenicity:
Mutation:
Other Studies:
No data available.

**** SECTION 12 - ECOLOGICAL INFORMATION ****

Ecotoxicity:
Not available.
Environmental Fate:
Not available.
Physical/Chemical:
Not available.
Other:
Not available.

**** SECTION 13 - DISPOSAL CONSIDERATIONS ****

Dispose of in a manner consistent with federal, state, and local regulations.
RCRA D-Series Maximum Concentration of Contaminants: Not listed.
RCRA D-Series Chronic Toxicity Reference Levels: Not listed.
RCRA F-Series: Not listed.
RCRA P-Series: Not listed.
RCRA U-Series: Not listed.
Not listed as a material banned from land disposal according to RCRA.

**** SECTION 14 - TRANSPORT INFORMATION ****

US DOT

No information available

IMO

Shipping Name: TOXIC LIQUID, ORGANIC, N.O.S.
Hazard Class: 6.1
UN Number: 2810
Packing Group: III

IATA

Shipping Name: TOXIC LIQUID, ORGANIC, N.O.S.*
Hazard Class: 6.1
UN Number: 2810
Packing Group: III

RID/ADR

Shipping Name: TOXIC LIQUID, ORGANIC, N.O.S.
Dangerous Goods Code: 6.1(25C)
UN Number: 2810

Canadian TDG
No information available.

**** SECTION 15 - REGULATORY INFORMATION ****

US FEDERAL
TSCA

CAS# 111-70-6 is listed on the TSCA inventory.
Health & Safety Reporting List
None of the chemicals are on the Health & Safety Reporting List.
Chemical Test Rules
None of the chemicals in this product are under a Chemical Test Rule.
Section 12b
None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.

SARA

Section 302 (RQ)
None of the chemicals in this material have an RQ.
Section 302 (TPQ)
None of the chemicals in this product have a TPQ.

SARA Codes

CAS # 111-70-6: acute, flammable.
Section 313

No chemicals are reportable under Section 313.

Clean Air Act:

This material does not contain any hazardous air pollutants.
This material does not contain any Class 1 Ozone depleters.
This material does not contain any Class 2 Ozone depleters.

Clean Water Act:

None of the chemicals in this product are listed as Hazardous Substances under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

Not present on state lists from CA, PA, MN, MA, FL, or NJ.
California No Significant Risk Level:
None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives
Hazard Symbols: XN
Risk Phrases:

R 21/22 Harmful in contact with skin and if
swallowed.

R 36 Irritating to eyes.

Safety Phrases:

S 26 In case of contact with eyes, rinse immediately
with plenty of water and seek medical advice.

S 36/37/39 Wear suitable protective clothing, gloves
and eye/face protection.

WGK (Water Danger/Protection)

CAS# 111-70-6: 1

Canada

CAS# 111-70-6 is listed on Canada's DSL/NDSL List.

This product has a WHMIS classification of B3, D1B.

CAS# 111-70-6 is not listed on Canada's Ingredient Disclosure List.

Exposure Limits

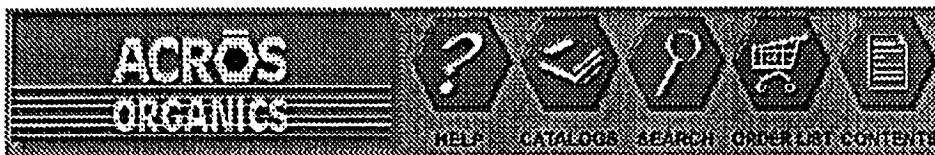
CAS# 111-70-6:.. OEL-RUSSIA:STEL 10 mg/m3;Skin

**** SECTION 16 - ADDITIONAL INFORMATION ****

MSDS Creation Date: 3/01/1994 Revision #1 Date: 10/10/1996

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[Back to product information.](#)



MATERIAL SAFETY DATA SHEET

Hexyl alcohol, 98%
96607

**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name: Hexyl alcohol, 98%

Synonyms:

1-Hexanol

Company Identification: Acros Organics N.V.
One Reagent Lane
Fairlawn, NJ 07410

For information in North America, call: 800-ACROS-01

For emergencies in the US, call CHEMTREC: 800-424-9300

For emergencies in the US, call CHEMTREC: 800-424-9300

**** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

CAS#	Chemical Name	%	EINECS#
111-27-3	Hexyl alcohol, 98%		203-852-3

Hazard Symbols: XN

Risk Phrases: 22

**** SECTION 3 - HAZARDS IDENTIFICATION ****

EMERGENCY OVERVIEW

Appearance: clear colourless liquid.

Target Organs: None.

Potential Health Effects

The toxicological properties of this material have not been investigated. Use appropriate procedures to prevent opportunities for direct contact with the skin or eyes and to prevent inhalation.

**** SECTION 4 - FIRST AID MEASURES ****

Eyes:

Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Get medical aid immediately.

Skin:

Get medical aid. Flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Remove contaminated clothing and shoes.

Ingestion:

If victim is conscious and alert, give 2-4 cupfuls of milk or water. Get medical aid immediately. Do NOT induce vomiting. Allow the victim to rinse his mouth and then to drink 2-4 cupfuls of water, and seek medical advice.

Inhalation:

Get medical aid immediately. Remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.

Notes to Physician:

Treat symptomatically and supportively.

**** SECTION 5 - FIRE FIGHTING MEASURES ****

General Information:

As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Flammable Liquid.

Extinguishing Media:

In case of fire, use water, dry chemical, chemical foam, or alcohol-resistant foam. Use agent most appropriate to extinguish fire.

Autoignition Temperature: 292 deg C (557.60 deg F)

Flash Point: 60 deg C (140.00 deg F)

NEPA Rating: health-1; flammability-2; reactivity-0

Explosion Limits, Lower: 1.20 vol %

Upper: 7.70 vol %

**** SECTION 6 - ACCIDENTAL RELEASE MEASURES ****

General Information: Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks:

Absorb spill with inert material, (e.g., dry sand or earth), then place into a chemical waste container. Clean up spills immediately, observing precautions in the Protective Equipment section.

**** SECTION 7 - HANDLING and STORAGE ****

Handling:

Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Avoid contact with heat, sparks and flame. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose empty containers to heat, sparks or open flames.

Storage:

Keep away from heat, sparks, and flame.

**** SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION ****

Engineering Controls:

Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits. Use process enclosure, local exhaust ventilation, or other engineering controls to control airborne levels.

Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Hexyl alcohol, 98%	none listed	none listed	none listed

OSHA Vacated PELs:

Hexyl alcohol, 98%:

No OSHA Vacated PELs are listed for this chemical.

Personal Protective Equipment

Eyes:

Wear chemical goggles. Wear safety glasses and chemical goggles if splashing is possible.

Skin:

Wear appropriate protective gloves and clothing to prevent skin exposure. Wear appropriate protective gloves to prevent skin exposure.

Clothing:

Wear appropriate protective clothing to minimize

contact with skin.

Respirators:

A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements must be followed whenever workplace conditions warrant a respirator's use. Wear a NIOSH/MSHA-approved (or equivalent) full-facepiece airline respirator in the positive pressure mode with emergency escape provisions.

**** SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES ****

Physical State:	Not available.
Appearance:	Not available.
Odor:	None reported.
pH:	Not available.
Vapor Pressure:	1.3 mbar @ 20 C
Vapor Density:	Not available.
Evaporation Rate:	Not available.
Viscosity:	5.3 mPas 20 deg
Boiling Point:	156.4 deg C @ 760.00mm Hg
Freezing/Melting Point:	-52 deg C
Decomposition Temperature:	Not available.
Solubility:	5.8 g/l (20 c)
Specific Gravity/Density:	.8140g/cm3
Molecular Formula:	C6H14O
Molecular Weight:	102.18

**** SECTION 10 - STABILITY AND REACTIVITY ****

Chemical Stability:

Stable under normal temperatures and pressures.

Conditions to Avoid:

Incompatible materials, strong oxidants.

Incompatibilities with Other Materials:

Strong oxidizing agents - strong acids.

Hazardous Decomposition Products:

Carbon monoxide, irritating and toxic fumes and gases, carbon dioxide.

Hazardous Polymerization: Has not been reported.

**** SECTION 11 - TOXICOLOGICAL INFORMATION ****

RTECS#:

CAS# 111-27-3: MQ4025000

LD50/LC50:

CAS# 111-27-3: Oral, mouse: LD50 = 1950 mg/kg; Oral, rat: LD50 = 720

mg/kg; Skin, rabbit: LD50 = 3100 mg/kg.
Carcinogenicity:
Hexyl alcohol, 98% -
Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.

**** SECTION 12 - ECOLOGICAL INFORMATION ****

Ecotoxicity:
Not available.

**** SECTION 13 - DISPOSAL CONSIDERATIONS ****

Dispose of in a manner consistent with federal, state, and local regulations.
RCRA D-Series Maximum Concentration of Contaminants: Not listed.
RCRA D-Series Chronic Toxicity Reference Levels: Not listed.
RCRA F-Series: Not listed.
RCRA P-Series: Not listed.
RCRA U-Series: Not listed.
Not listed as a material banned from land disposal according to RCRA.

**** SECTION 14 - TRANSPORT INFORMATION ****

US DOT

Shipping Name: HEXANOLS
Hazard Class: 3
UN Number: UN2282
Packing Group: III

IMO

Shipping Name: HEXANOLS
Hazard Class: 3.3
UN Number: 2282
Packing Group: III

IATA

Shipping Name: HEXANOLS
Hazard Class: 3
UN Number: 2282
Packing Group: III

RID/ADR

Shipping Name: HEXANOLS
Dangerous Goods Code: 3(31C)
UN Number: 2282

Canadian TDG

Shipping Name: HEXANOLS
Hazard Class: 3
UN Number: UN2282

Other Information: FLASHPOINT 60 C

**** SECTION 15 - REGULATORY INFORMATION ****

US FEDERAL

TSCA

CAS# 111-27-3 is listed on the TSCA inventory.

Health & Safety Reporting List

None of the chemicals are on the Health & Safety Reporting List.

Chemical Test Rules

None of the chemicals in this product are under a Chemical Test Rule.

Section 12b

None of the chemicals are listed under TSCA Section 12b.

TSCA Significant New Use Rule

None of the chemicals in this material have a SNUR under TSCA.

SARA

Section 302 (RQ)

None of the chemicals in this material have an RQ.

Section 302 (TPQ)

None of the chemicals in this product have a TPQ.

SARA Codes

CAS # 111-27-3: acute, flammable.

Section 313

No chemicals are reportable under Section 313.

Clean Air Act:

This material does not contain any hazardous air pollutants.

This material does not contain any Class 1 Ozone depleters.

This material does not contain any Class 2 Ozone depleters.

Clean Water Act:

None of the chemicals in this product are listed as Hazardous Substances under the CWA.

None of the chemicals in this product are listed as Priority Pollutants under the CWA.

None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

Hexyl alcohol, 98% can be found on the following state right to know lists: New Jersey, Pennsylvania.

California No Significant Risk Level:

None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols: XN

Risk Phrases:

R 22 Harmful if swallowed.

Safety Phrases:

S 24/25 Avoid contact with skin and eyes.

WGK (Water Danger/Protection)

CAS# 111-27-3: 1

Canada

CAS# 111-27-3 is listed on Canada's DSL/NDSL List.

This product has a WHMIS classification of B3, D2B.

CAS# 111-27-3 is listed on Canada's Ingredient Disclosure List.

Exposure Limits

**** SECTION 16 - ADDITIONAL INFORMATION ****

MSDS Creation Date: 2/01/1996 Revision #0 Date: Original.

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[Back to product information.](#)



MATERIAL SAFETY DATA SHEET

2-Ethyl-1-Hexanol, 99%
59765

**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name: 2-Ethyl-1-Hexanol, 99%

1-Hexanol, 2- Ethyl; 2 Ethylhexanol; Octyl Alcohol
Company Identification: Acros Organics N.V.
One Reagent Lane
Fairlawn, NJ 07410
For information in North America, call: 800-ACROS-01
For emergencies in the US, call CHEMTREC: 800-424-9300
For emergencies in the US, call CHEMTREC: 800-424-9300

**** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

CAS#	Chemical Name	%	EINECS#
104-76-7	2-Ethyl-1-Hexanol	99%	203-234-3

Hazard Symbols: XN
Risk Phrases: 21 36

**** SECTION 3 - HAZARDS IDENTIFICATION ****

EMERGENCY OVERVIEW

Appearance: colorless liquid. Flash Point: 77 deg C.
Caution! Combustible liquid. May cause skin irritation. May cause respiratory and digestive tract irritation. Causes eye irritation.
Target Organs: Kidneys, liver.

Potential Health Effects

Eye:

Causes eye irritation.

Skin:

May cause skin irritation.

Ingestion:

May cause irritation of the digestive tract.

Inhalation:

May cause respiratory tract irritation.

Chronic:

Not available.

**** SECTION 4 - FIRST AID MEASURES ****

Eyes:

Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower lids. Get medical aid immediately.

Skin:

Get medical aid immediately. Flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes.

Ingestion:

If victim is conscious and alert, give 2-4 cupfuls of milk or water. Get medical aid immediately. May cause irritation of the digestive tract and possible burns.

Inhalation:

Get medical aid immediately. Remove from exposure to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen.

Notes to Physician:

Treat symptomatically and supportively.

**** SECTION 5 - FIRE FIGHTING MEASURES ****

General Information:

As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Vapors can travel to a source of ignition and flash back. Combustible Liquid. Vapors may be heavier than air. They can spread along the ground and collect in low or confined areas.

Extinguishing Media:

In case of fire use water fog, dry chemical, carbon dioxide or alcohol type foam.

Autoignition Temperature: 270 deg C (518.00 deg F)

Flash Point: 77 deg C (170.60 deg F)

NFPA Rating: health-2; flammability-2; reactivity-0

Explosion Limits, Lower: 1.10 vol %
Upper: 7.40 vol %

**** SECTION 6 - ACCIDENTAL RELEASE MEASURES ****

General Information: Use proper personal protective equipment as indicated in Section 8.

Spills/Leaks:

Absorb spill with inert material, (e.g., dry sand or earth), then place into a chemical waste container. Clean up spills immediately, observing precautions in the Protective Equipment section.

**** SECTION 7 - HANDLING and STORAGE ****

Handling:

Wash thoroughly after handling. Use only in a well ventilated area. Avoid contact with eyes, skin, and clothing. Avoid ingestion and inhalation.

Storage:

Keep away from heat, sparks, and flame. Keep away from sources of ignition. Store in a cool, dry place. Keep container closed when not in use.

**** SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION ****

Engineering Controls:

Use adequate ventilation to keep airborne concentrations low.

Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
2-Ethyl-1-Hexanol	none listed	none listed	none listed

OSHA Vacated PELs:

2-Ethyl-1-Hexanol:

No OSHA Vacated PELs are listed for this chemical.

Personal Protective Equipment

Eyes:

Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133.

Skin:

Wear appropriate protective gloves to prevent skin

exposure.
Clothing: Wear appropriate protective clothing to prevent skin exposure.
Respirators: Follow the OSHA respirator regulations found in 29CFR 1910.134. Always use a NIOSH-approved respirator when necessary.

**** SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES ****

Physical State: Liquid
Appearance: colorless liquid
Odor: floral-like
pH: Not available.
Vapor Pressure: 0.36 hPa @ 20 C
Vapor Density: 4.5
Evaporation Rate: Not available.
Viscosity: 10 mPas 20 deg
Boiling Point: 183.0 - 186.0 deg C @ 760.00m
Freezing/Melting Point: 0 deg C
Decomposition Temperature: Not available.
Solubility: 0.1g/100ml (20 c)
Specific Gravity/Density: .8330g/cm3
Molecular Formula: C8H18O
Molecular Weight: 130.23

**** SECTION 10 - STABILITY AND REACTIVITY ****

Chemical Stability:
Stable under normal temperatures and pressures.
Conditions to Avoid:
Not available.
Incompatibilities with Other Materials:
Strong oxidizing agents, strong acids.
Hazardous Decomposition Products:
Carbon monoxide, carbon dioxide.
Hazardous Polymerization: Has not been reported.

**** SECTION 11 - TOXICOLOGICAL INFORMATION ****

RTECS#:
CAS# 104-76-7: MP0350000
LD50/LC50:
CAS# 104-76-7: Oral, mouse: LD50 = 2500 mg/kg; Oral, rabbit: LD50 = 1180 mg/kg; Oral, rat: LD50 = 2049 mg/kg; Skin, rabbit: LD50 = 1970 mg/kg.

Carcinogenicity:

2-Ethyl-1-Hexanol -

Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.

Epidemiology:

No data available.

Teratogenicity:

No data available.

Reproductive Effects:

No data available.

Neurotoxicity:

No data available.

Mutagenicity:

No data available.

Other Studies:

No data available.

**** SECTION 12 - ECOLOGICAL INFORMATION ****

Ecotoxicity:

Not available.

Environmental Fate:

Not available.

Physical/Chemical:

Not available.

Other:

Not available.

**** SECTION 13 - DISPOSAL CONSIDERATIONS ****

Dispose of in a manner consistent with federal, state, and local regulations.

RCRA D-Series Maximum Concentration of Contaminants: Not listed.

RCRA D-Series Chronic Toxicity Reference Levels: Not listed.

RCRA F-Series: Not listed.

RCRA P-Series: Not listed.

RCRA U-Series: Not listed.

Not listed as a material banned from land disposal according to RCRA.

**** SECTION 14 - TRANSPORT INFORMATION ****

US DOT

No information available

IMO

Not regulated as a hazardous material.

IATA

Not regulated as a hazardous material.

RID/ADR

Not regulated as a hazardous material.

Canadian TDG
No information available.

**** SECTION 15 - REGULATORY INFORMATION ****

US FEDERAL
TSCA

CAS# 104-76-7 is listed on the TSCA inventory.
Health & Safety Reporting List
CAS# 104-76-7: Effective Date: June 1, 1987
Chemical Test Rules
CAS# 104-76-7: Testing required by: manufacturers; processors (40 CFR
Section 12b
CAS# 104-76-7: export notification required - Section 4
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.

SARA

Section 302 (RQ)
None of the chemicals in this material have an RQ.
Section 302 (TPQ)
None of the chemicals in this product have a TPQ.
SARA Codes
CAS # 104-76-7: acute, chronic, flammable.
Section 313
No chemicals are reportable under Section 313.

Clean Air Act:

This material does not contain any hazardous air pollutants.
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.

Clean Water Act:

None of the chemicals in this product are listed as Hazardous
Substances under the CWA.
None of the chemicals in this product are listed as Priority
Pollutants under the CWA.
None of the chemicals in this product are listed as Toxic Pollutants
under the CWA.

OSHA:

None of the chemicals in this product are considered highly hazardous
by OSHA.

STATE

2-Ethyl-1-Hexanol can be found on the following state right to know
lists: Florida, Pennsylvania, Massachusetts.
California No Significant Risk Level:
None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives
Hazard Symbols: XN

Risk Phrases:

- R 21 Harmful in contact with skin.
- R 36 Irritating to eyes.

Safety Phrases:

- S 23 Do not inhale gas/fumes/vapour/spray.
- S 24/25 Avoid contact with skin and eyes.

WGK (Water Danger/Protection)

CAS# 104-76-7: 2

Canada

CAS# 104-76-7 is listed on Canada's DSL/NDSL List.

This product has a WHMIS classification of B3, D2B.

CAS# 104-76-7 is listed on Canada's Ingredient Disclosure List.

Exposure Limits

**** SECTION 16 - ADDITIONAL INFORMATION ****

MSDS Creation Date: 3/01/1994 Revision #1 Date: 3/04/1996

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no way shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.

[Back to product information.](#)

Institute of Medicine
Food and Nutrition Board
Committee on Food Chemicals Codex

Revised Monograph - Calcium Chloride

Please send comments to the Committee on Food Chemicals Codex, National Academy of Sciences, 3042, 2101 Constitution Avenue, N.W., Washington, DC 20418 or email them to fcc@nas.edu. All comments must be received by February 17, 1997, for consideration for the First Supplement.

Calcium Chloride

September 16, 1996

$\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$

CaCl_2

Formula wt, dihydrate 147.01

Formula wt, anhydrous 110.98

INS: 509

CAS: dihydrate [10035-04-8]

CAS: anhydrous [10043-52-4]

DESCRIPTION

White, hard, odorless fragments, granules, or powder. It is deliquescent. It is anhydrous or the dihydrate. It is soluble in water and slightly soluble in alcohol. The pH of a 1 in 20 solution is between 4.5 and 9.0-5.

Functional Use in Foods: Sequestrant; firming agent.

REQUIREMENTS

Labeling: Indicate whether it is the dihydrate or anhydrous.

Identification: A 1 in 10 solution gives positive tests for Calcium and for Chloride, Appendix IIIA.

Assay: For the dihydrate, not less than 99.0% and not more than 107.0% of $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$; for the anhydrous, not less than 93.0% and not more than 100.5% of CaCl_2 .

Acid-Insoluble Matter (for the anhydrous): Not more than 0.02%; no particles per kg of sample greater than 2 mm in any dimension.

Arsenic (as As): Not more than 3 mg/kg.

Fluoride: Not more than 0.004%.

Heavy Metals (as Pb): Not more than 0.002%.

Lead: Not more than 5 mg/kg.

Magnesium and Alkali Salts: Not more than 4.0% for the dihydrate, and not more than 5.0% for the anhydrous.

TESTS

Assay: Transfer about 1.5 g, accurately weighed, into a 250-mL volumetric flask, dissolve it in a mixture of 100 mL of water and 5 mL of 2.7 N hydrochloric acid, dilute to volume with water, and mix. Transfer 50.0 mL of this solution into a suitable container, and add 50 mL of water. While stirring, preferably with a magnetic stirrer, add about 30 mL of 0.05 M disodium EDTA from a 50-mL buret, then add 15 mL of 1 N sodium hydroxide and 300 mg of hydroxy naphthol blue indicator, and continue the titration to a blue endpoint. Each mL of 0.05 M disodium EDTA is equivalent to 5.55 mg of CaCl_2 or 7.35 mg of $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$.

Acid-Insoluble Matter: (Note: The following test is intended for Anhydrous Calcium Chloride.) Place a 32-mm od lintine disc filter¹ in a suitable filter assembly comprising a 2.5-L screw-cap bottle cut in half horizontally and

¹Available from Filter Fabrics, Inc., 814 E. Jefferson, Goshen, IN 46526; 219/533-3114.

[Code of Federal Regulations]
[Title 21, Volume 3, Parts 170 to 199]
[Revised as of April 1, 1997]
From the U.S. Government Printing Office via GPO Access
[CITE: 21CFR184.1193]

[Page 460-461]

TITLE 21--FOOD AND DRUGS

CHAPTER I--FOOD AND DRUG ADMINISTRATION, DEPARTMENT OF HEALTH AND HUMAN SERVICES (

PART 184--DIRECT FOOD SUBSTANCES AFFIRMED AS GENERALLY RECOGNIZED AS SAFE--Table o

Subpart B--Listing of Specific Substances Affirmed as GRAS

Sec. 184.1193 Calcium chloride.

(a) Calcium chloride ($\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$), CAS Reg. No. 10035-04-8) or anhydrous calcium chloride (CaCl_2), CAS Reg. No. 10043-52-4) may be commercially obtained as a byproduct in the ammonia-soda (Solvay) process and as a joint product from natural salt brines, or it may be prepared by substitution reactions with other calcium and chloride salts.

(b) The ingredient meets the specifications of the Food Chemicals Codex, 3d Ed. (1981), p. 47, which is incorporated by reference. Copies are available from the National Academy Press, 2101 Constitution Ave. NW., Washington, DC 20418, or available for inspection at the Office of the Federal Register, 800 North Capitol Street, NW., suite 700, Washington, DC 20408.

(c) The ingredient is used as an anticaking agent as defined in Sec. 170.3(o)(1) of this chapter; antimicrobial agent as defined in Sec. 170.3(o)(2) of this chapter; curing or pickling agent as defined in Sec. 170.3(o)(5) of this chapter; firming agent as defined in Sec. 170.3(o)(10) of this chapter; flavor enhancer as defined in Sec. 170.3(o)(11) of this chapter; humectant as defined in Sec. 170.3(o)(16) of this chapter; nutrient supplement as defined in Sec. 170.3(o)(20) of this chapter; pH control agent as defined in Sec. 170.3(o)(23) of this chapter; processing aid as defined in Sec. 170.3(o)(24) of this chapter; stabilizer and thickener as defined in Sec. 170.3(o)(28) of this chapter; surface-active agent as defined in Sec. 170.3(o)(29) of this chapter; synergist as defined in Sec. 170.3(o)(31) of this chapter; and texturizer as defined in Sec. 170.3(o)(32) of this chapter.

(d) The ingredient is used in foods at levels not to exceed current good manufacturing practices in accordance with Sec. 184.1(b)(1). Current good manufacturing practices result in a maximum level, as served, of 0.3 percent for baked goods as defined in Sec. 170.3(n)(1) of this chapter and for dairy product analogs as defined in Sec. 170.3(n)(10) of this chapter; 0.22 percent for nonalcoholic beverages and beverage bases

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as defined in Sec. 170.3(n)(3) of this chapter; 0.2 percent for cheese as defined in Sec. 170.3(n)(5) of this chapter and for processed fruit and fruit juices as defined in Sec. 170.3(n)(35) of this chapter; 0.32 percent for coffee and tea as defined in Sec. 170.3(n)(7) of this chapter; 0.4 percent for condiments and relishes as defined in Sec. 170.3(n)(8) of this chapter; 0.2 percent for gravies and sauces as defined in Sec. 170.3(n)(24) of this chapter; 0.1 percent for commercial jams and jellies as defined in Sec. 170.3(n)(28) of this chapter; 0.25

percent for meat products as defined in Sec. 170.3(n)(29) of this chapter; 2.0 percent for plant protein products as defined in Sec. 170.3(n)(33) of this chapter; 0.4 percent for processed vegetables and vegetable juices as defined in Sec. 170.3(n)(36) of this chapter; and 0.05 percent for all other food categories.

(e) Prior sanctions for this ingredient different from the uses established in this section do not exist or have been waived.

[47 FR 27808, June 25, 1982, as amended at 61 FR 14247, Apr. 1, 1996]

Van Waters & Rogers Inc.
**** Material Safety Data Sheet ****

Date: 03/12/98

Time: 08:48:47

To: FRED HOLZMER
FRED HOLZMER

Fax: 1512-425-2099

From: EVA COLLIER

Phone: 800-438-1119

Re: MSDS - BRINERS CHOICE (R) ANHYDROUS CALCIUM CHLORIDE PELLETS

REMARKS:



Fax Cover Sheet

Including this cover sheet, you should receive 7 pages.

For emergency assistance involving chemicals,
call CHEMTREC - (800) 424-9300

Van Waters & Rogers, subsidiary of UNIVAR
6100 Carillon Point, Kirkland, WA 98033 206-889-3400

000-150-1113 3/12/96 U.S. VAH WHITERS & ROBERTS P. L.
1 06/05/96 BRINERS CHOICE (R) ANHYDROUS CALCIUM CHLORIDE PELLETS

PRODUCT NAME:
BRINERS CHOICE (R) ANHYDROUS CALCIUM CHLORIDE PELLETS

DS #: DW42028

COMPOSITION/INFORMATION ON INGREDIENTS

Calcium chloride	CAS# 010043-52-4	93-96%
Water	CAS# 007732-18-5	0- 2%
Sodium chloride	CAS# 007647-14-5	1- 2%
Potassium chloride	CAS# 007447-40-7	2- 3%
Strontium chloride	CAS# 010476-85-4	0- 1%

HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

White to off-white solid pellets. Odorless. Causes eye irritation.

POTENTIAL HEALTH EFFECTS (See Section 11 for toxicological data.)

EYE: Pellets may cause slight eye irritation. Dusts may cause severe irritation with corneal injury. Effects may be slow to heal. When dissolving, the heat produced may cause more intense effects as well as thermal burns.

SKIN: Short single exposure not likely to cause significant skin irritation. Prolonged or repeated exposure may cause skin irritation, even a burn. May cause more severe response if skin is damp or if material is confined to skin. May cause more severe response if skin is abraded (scratched or cut). When dissolving, the heat produced may cause more intense effects as well as thermal burns. Not classified as corrosive according to DOT. A single prolonged exposure is not likely to result in the material being absorbed through skin in harmful amounts.

INGESTION: Single dose oral toxicity is considered to be low. Small amounts swallowed incidental to normal handling operations are not likely to cause injury; swallowing amounts larger than that may cause injury. Ingestion may cause gastrointestinal irritation or ulceration.

INHALATION: Vapors are unlikely due to physical properties. Dust may cause irritation to upper respiratory tract.

SYSTEMIC & OTHER EFFECTS: No relevant information found.

FIRST AID

EYES: Irrigate with flowing water immediately and continuously for 15 minutes. Consult medical personnel.

SKIN: Wash off in flowing water or shower.

INGESTION: If swallowed, seek medical attention. Do not induce vomiting unless directed to do so by medical personnel.

INHALATION: Remove to fresh air if effects occur. Consult a physician.

NOTE TO PHYSICIAN: If burn is present, treat as any thermal burn, after decontamination. No specific antidote. Supportive care. Treatment based on judgment of the physician in response to reactions of the patient.

FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES

FLASH POINT: Not applicable.

METHOD USED: Not applicable.

FLAMMABILITY LIMITS

LFL: Not applicable.

UFL: Not applicable.

HAZARDOUS COMBUSTION PRODUCTS: Not applicable.

EXTINGUISHING MEDIA: This material does not burn. If exposed to fire from another source, use suitable extinguishing agent for that fire.

FIRE FIGHTING INSTRUCTIONS: Keep people away. Isolate fire area and deny unnecessary entry.

PROTECTIVE EQUIPMENT FOR FIRE FIGHTERS: Wear positive-pressure self-contained breathing apparatus (SCBA) and full protective fire fighting clothing (includes fire fighting helmet, coat, pants, boots, and gloves).

ACCIDENTAL RELEASE MEASURES (See Section 15 for Regulatory Information)

PROTECT PEOPLE: Isolate area. Avoid contact with eyes and skin. May be a slipping hazard. Stop leak if it can be done safely. Wash exposed body areas thoroughly after handling. Use appropriate safety equipment. For additional information, refer to "Exposure Controls/Personnel Protection", MSDS Section 8.

PROTECT THE ENVIRONMENT: For small spills: Losses incidental to correct applications of this product in its intended uses are not expected to be harmful to the environment.

For large spills: Avoid contamination of drinking water, natural water, ground water or any waterway. Losses incidental to correct applications of this product in its intended uses are not expected to be harmful to the environment.

CLEANUP: For small spills: Contain spill if possible. Collect material in a suitable and properly labeled containers. Flush residue with plenty of water.

For large spills: Dike and transfer to suitable and properly labeled containers. Flush residue with plenty of water.

HANDLING AND STORAGE

HANDLING: Heat developed during diluting or dissolving is very high. Use cool water when diluting or dissolving (temperature less than 80F, 27C).

Refer to Exposure Controls/Personal Protection, Section 8, of the MSDS.

For more storage and Handling Information refer to bulletin 173-01534.

STORAGE: Keep containers tightly closed when not in use. Store in a dry place. Protect from atmospheric moisture.

EXPOSURE CONTROLS/PERSONAL PROTECTION

ENGINEERING CONTROLS: Provide general and/or local exhaust ventilation to control airborne levels below the exposure guidelines.

PERSONAL PROTECTIVE EQUIPMENT

EYE/FACE PROTECTION: Use safety glasses. For dusty operations or when handling solutions of the material, wear chemical goggles.

SKIN PROTECTION: For brief contact, no precautions other than clean body-covering clothing should be needed. Use protective clothing impervious to this material. Selection of specific items such as faceshield, gloves, boots, apron or full-body suit will depend on operation. If skin comes in contact with contaminated clothing, remove the clothing immediately, wash skin area with soap and water and launder clothing before reuse. If hands are cut or scratched, use gloves impervious to this material even for brief exposures. Leather clothing and shoes will be damaged by calcium chloride.

RESPIRATORY PROTECTION: Atmospheric levels should be maintained below the exposure guideline. When respiratory protection is required for certain operations, use an approved air-purifying respirator. In dusty atmospheres, use an approved dust respirator.

EXPOSURE GUIDELINES: Calcium chloride: Dow IHG is 10 mg/m³.
Sodium Chloride: Dow IHG is 10 mg/m³.
Potassium chloride: Dow IHG is 10 mg/m³.

PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE: White to off white, solid - pellets.

ODOR: Odorless.

MELTING POINT: Approx. 1424F, 772C

BOILING POINT: >1500F, >815C

VAP. PRESS: <0.005 mmHg @ 20C

VAP. DENSITY: Not applicable.

SOL. IN WATER: Very soluble.

SP. GRAVITY: 2.2

STABILITY AND REACTIVITY

CHEMICAL STABILITY: Stable. Hygroscopic.

CONDITIONS TO AVOID: None known.

INCOMPATIBILITY WITH OTHER MATERIALS: Corrosive to some metals. Avoid contact with metals such as: brass, mild steel, aluminum, or ferrous metals. Flammable hydrogen may be generated from contact with metals such as zinc or sodium. Avoid contact with sulfuric acid. Heat is generated when mixed with water. Spattering or boiling can occur.

HAZARDOUS DECOMPOSITION PRODUCTS: Does not decompose.

HAZARDOUS POLYMERIZATION: Will not occur.

TOXICOLOGICAL INFORMATION (See Section 3 for Potential Health Effects. For detailed toxicological data, write or call the address or non-emergency number shown in Section 1)

ACUTE

SKIN: The LD50 for skin absorption in rabbits is > 5000 mg/kg.

INGESTION: The oral LD50 for rats is between 967-1668 mg/kg.

MUTAGENICTY (EFFECTS ON GENETIC MATERIAL): For CaCl₂, in vitro mutagenicity studies were negative.

ECOLOGICAL INFORMATION (For detailed Ecological data, write or call the address or non-emergency number shown in Section 1)

ENVIRONMENTAL FATE

MOVEMENT & PARTITIONING: Partitioning from water to n-octanol is not applicable.

DEGRADATION & PERSISTANCE: Biodegradation is not applicable.

ECOTOXICOLOGY: Based largely or completely on data for major component(s). Material is practically non-toxic to aquatic organisms on an acute basis (LC50 greater than 100 mg/L in most sensitive species).

DISPOSAL CONSIDERATIONS (See Section 15 for Regulatory Information)

DISPOSAL: DO NOT DUMP INTO ANY SEWERS, ON THE GROUND, OR INTO ANY BODY OF WATER. All disposal methods must be in compliance with all Federal, State/Provincial and local laws and regulations. Regulations may vary in different locations. Waste characterizations and compliance with applicable laws are the responsibility solely of the waste generator. THE DOW CHEMICAL COMPANY HAS NO CONTROL OVER THE MANAGEMENT PRACTICES OR MANUFACTURING PROCESSES OF PARTIES HANDLING OR USING THIS MATERIAL. THE INFORMATION PRESENTED HERE PERTAINS ONLY TO THE PRODUCT AS SHIPPED IN ITS INTENDED CONDITION AS DESCRIBED IN MSDS SECTION 2 (Composition/Information On Ingredients).

FOR UNUSED & UNCONTAMINATED PRODUCT, the preferred options include sending to a licensed, permitted: reclaimer, landfill, or waste water treatment system.

For additional information, refer to:

- Handling & Storage Information, MSDS Section 7.
- Stability & Reactivity Information, MSDS Section 10.
- Regulatory Information, MSDS Section 15.

As a service to its customers, Dow can provide lists of companies which recycle, reprocess or manage chemicals or plastics, and companies that manage used drums. Telephone Dow's Customer Information Center at 800-258-2436 or 517-832-1556 for further details.

TRANSPORT INFORMATION

UNITED STATES DOT INFORMATION:

This product is not regulated by D.O.T. when shipped domestically by land.

CANADIAN TDG INFORMATION:

This product is not regulated by T.D.G. when shipped domestically by land.

REGULATORY INFORMATION (Not meant to be all-inclusive--selected regulations represented)

NOTE: The information herein is presented in good faith and

lied to be accurate as of the effective date shown above. However, warranty, express or implied is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state or provincial, and local laws. The following specific information is made for the purpose of complying with numerous federal, state or provincial, and local laws and regulations. See other sections for health and safety information.

RA 313 INFORMATION: To the best of our knowledge, this product contains no chemical subject to SARA Title III Section 313 supplier notification requirements.

RA HAZARD CATEGORY: This product has been reviewed according to the A "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and considered, under applicable definitions, to meet the following categories:

Immediate health hazard

This product has been categorized as an "immediate health hazard" due to possible effects on the eye.

TSCA SUBSTANCES CONTROL ACT (TSCA):

1 ingredient is on the TSCA inventory or are not required to be listed on the TSCA inventory.

CAS number(s) for TSCA is(are):

S# 010043-52-4
S# 007647-14-5
S# 007447-40-7
S# 010476-85-4
S# 007732-18-5

STATE RIGHT-TO-KNOW: This product is not known to contain any substances subject to the disclosure requirements of

New Jersey
Pennsylvania

HAZARD COMMUNICATION STANDARD:

This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

This product has been categorized as a "Hazardous Chemical" due to possible effects on the eye.

COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT (CERCLA, or SUPERFUND):

To the best of our knowledge, this product contains no chemical subject to reporting under CERCLA.

ADIAN REGULATIONS
=====

THIS INFORMATION: The Canadian Workplace Hazardous Materials
Information System (WHMIS) Classification for this product is:

- eye or skin irritant

Refer elsewhere in the MSDS for specific warnings and
safe handling information. Refer to the employer's
workplace education program.

STATEMENT: This product has been classified in accordance with the
hazard criteria of the Canadian Controlled Products Regulations (CPR)
the MSDS contains all the information required by the CPR.

HAZARDOUS PRODUCTS ACT INFORMATION: This product contains the following
ingredients which are Controlled Products and/or on the Ingredient
Disclosure List (Canadian HPA section 13 and 14):

COMPONENTS:	CAS #	AMOUNT (%W/W)
Calcium chloride	CAS# 010043-52-4	93-96%

OTHER INFORMATION

STATUS: Revised sections 3, 4, 5, 6, 7, 8, 10, 11, 12, 13 and 14.

INDICATES A TRADEMARK OF THE DOW CHEMICAL COMPANY

----- NOTICE -----

VAN WATERS & ROGERS INC. ("VW&R") EXPRESSLY DISCLAIMS ALL EXPRESS OR

IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE,

IN RESPECT TO THE PRODUCT OR INFORMATION PROVIDED HEREIN, AND SHALL UNDER

CIRCUMSTANCES BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.**

ALL INFORMATION APPEARING HEREIN IS BASED UPON DATA OBTAINED FROM THE
MANUFACTURER AND/OR RECOGNIZED TECHNICAL SOURCES. WHILE THE INFORMATION IS
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DETERMINE WHETHER THE PRODUCT IS SUITABLE FOR THEIR PARTICULAR PURPOSES AND THEY
ASSUME ALL RISKS OF THEIR USE, HANDLING, AND DISPOSAL OF THE PRODUCT, OR FROM
PUBLICATION OR USE OF, OR RELIANCE UPON, INFORMATION CONTAINED HEREIN.
THIS INFORMATION RELATES ONLY TO THE PRODUCT DESIGNATED HEREIN, AND DOES NOT
RELATE TO ITS USE IN COMBINATION WITH ANY OTHER MATERIAL OR IN ANY OTHER
PROCESS.

* * * E N D O F M S D S * * *



Section 1. Material Identification

Perchloroethylene (C₂Cl₄) Description: By chlorination of hydrocarbons and pyrolysis of the carbon tetrachloride that is formed, or by catalytic oxidation of 1,1,2,2-tetrachloroethane. Used in dry cleaning and textile processing, metal degreasing, insulating fluid and cooling gas in electrical transformers, production of adhesives, aerosols, paints, and coatings; as a chemical intermediate, a solvent for various applications, extractant for pharmaceuticals, a pesticide intermediate, and an anthelmintic (parasitic worm removal) agent in veterinary medicine.

Other Designations: CAS No. 127-18-4, Ankilostin, carbon dichloride, Didakene, ethylene tetrachloride, Perchlor, Perciene, Perk, Tetracap, tetrachloroethylene.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*⁽⁷³⁾ for a suppliers list.

R 1
I 3
S 2*
K 0
* Skin
absorption

NFPA



HMIS

H 2+

F 0

R 0

PPE†

† Chronic effects

† Sec. 8

Cautions: Perchloroethylene is a central nervous system depressant, causes liver and kidney damage (from acute or chronic exposures), and is considered an IARC Class 2B carcinogen (animal sufficient evidence, human inadequate data).

Section 2. Ingredients and Occupational Exposure Limits

Perchloroethylene, < 99%. Impurities include a small amount of amine or phenolic stabilizers.

1991 OSHA PEL

8-hr TWA: 25 ppm (170 mg/m³)

1990 IDLH Level

500 ppm

1990 NIOSH REL

NIOSH-X Carcinogen

Limit of Quantitation: 0.4 ppm

1992-93 ACGIH TLVs

TWA: 50 ppm (339 mg/m³)

STEL: 200 ppm (1357 mg/m³)

1990 DFG (Germany) MAK

TWA: 50 ppm (345 mg/m³)

Category II: substances with systemic effects

Half-life: < 2 hr

Peak Exposure Limit: 100 ppm, 30 min average value, 4/shift

1985-86 Toxicity Data*

Man, inhalation, TC_{Lo}: 280 ppm/2 hr caused conjunctival irritation and anesthesia.

Human, lung: 100 mg/L caused unscheduled DNA synthesis.

Rat, oral, LD₅₀: 3005 mg/kg; caused somnolence, tremor, and ataxia.

Rat, inhalation, TC_{Lo}: 200 ppm/6 hr given intermittently over 2 years produced leukemia and testicular tumors.

Rabbit, eye: 162 mg caused mild irritation.

Rabbit, skin: 810 mg/24 hr caused severe irritation.

* See NIOSH, RTECS (KX3850000), for additional irritation, mutation, reproductive, tumorigenic, & toxicity data.

Section 3. Physical Data

Boiling Point: 250 °F (121.2 °C)

Freezing Point: -8 °F (-23.35 °C)

Vapor Pressure: 13 mm Hg at 68 °F (20 °C)

Surface Tension: 31.74 dyne/cm at 68 °F (20 °C)

Viscosity: 0.84 cP at 77 °F (25 °C)

Refraction Index: 1.50534 at 68 °F (20 °C)

Molecular Weight: 165.82

Density: 1.6311 at 59 °F (15/4 °C)

Water Solubility: 0.02% at 77 °F (25 °C)

Other Solubilities: Miscible with alcohol, ether, benzene, chloroform, and oils.

Odor Threshold: 47 to 71 ppm (poor warning properties since olfactory fatigue is probable)

Evaporation Rate: 0.15 gal/ft²/day at 77 °F (25 °C)

Saturated Vapor Density (Air = 0.075 lb/ft³ or 1.2 kg/m³): 0.081 lb/ft³ or 1.296 kg/m³

Appearance and Odor: Colorless liquid with an ether-like odor.

Section 4. Fire and Explosion Data

Flash Point: Nonflammable

Autoignition Temperature: Nonflammable

LEL: None reported

UEL: None reported

Extinguishing Media: For small fires, use dry chemical, carbon dioxide (CO₂). For large fires, use water spray, fog, or regular foam.

Unusual Fire or Explosion Hazards: Vapors are heavier than air and collect in low-lying areas.

Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Apply cooling water to sides of container until well after fire is out. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Perchloroethylene is stable up to 932 °F (500 °C) in the absence of catalysts, moisture, and oxygen but deteriorates rapidly in warm, moist climates. It is slowly decomposed by light. Amine or phenolic stabilizers are usually added. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Slowly (faster in presence of water) corrodes aluminum, iron, and zinc. It is incompatible with chemically active metals (i.e., barium, beryllium, and lithium (explodes with lithium shavings), strong oxidizers, sodium hydroxide, caustic soda, potash, and nitric acid. Perchloroethylene forms an explosive mixture with dinitrogen tetroxide and reacts with activated charcoal at 392 °F (200 °C) to yield hexachloroethane and hexachlorobenzene. **Conditions to Avoid:** Contact with moisture and incompatibles.

Hazardous Products of Decomposition: Thermal oxidative decomposition of perchloroethylene can produce carbon dioxide and toxic chlorine, hydrogen chloride, and phosgene gas (also produced by contact with UV light).

Section 6. Health Hazard Data

Carcinogenicity: Perchloroethylene is listed as a carcinogen by The IARC (Group 2B, animal sufficient evidence, human inadequate data),⁽¹⁶⁴⁾ NTP (Class 2, reasonably anticipated as a carcinogen, with limited human evidence and sufficient animal evidence),⁽¹⁶⁹⁾ NIOSH (Class-X, carcinogen defined with no further explanation),⁽¹⁶⁴⁾ and DFG (MAK-B, justifiably suspected of having carcinogenic potential).⁽¹⁶⁴⁾ There is some controversy regarding human carcinogenicity because even though there is an increased number of cancers of the skin, colon, lung, urogenital tract, and lympho-sarcomas; the dry cleaning workers studied were also exposed to other chemicals. **Summary of Risks:** Perchloroethylene is stored in the fatty tissue and slowly metabolized with the loss of chlorine. The half-life of its urinary metabolite (trichloroacetic acid) is 144 hours. Perchloroethylene exerts the majority of its toxicity on the central nervous system causing symptoms ranging from light-headedness and slight 'inebriation' to unconsciousness. Liver damage is possible after severe acute or minor long-term exposure. It has a synergistic effect with toluene.

Continue on next page

Section 6. Health Hazard Data, continued

Medical Conditions Aggravated by Long-Term Exposure: Nervous, liver, kidney, or skin disorders. **Target Organs:** Liver, kidney, eyes, upper respiratory tract, skin, and central nervous system. **Primary Entry Routes:** Inhalation and skin and eye contact. **Acute Effects:** Exposure to high levels can cause liver damage which may take several weeks to develop. Vapor exposure can cause slight smarting of the eyes and throat (in high concentrations). In human studies, exposure to 2000 ppm/5 min caused mild CNS depression; 600 ppm/10 min caused numbness around the mouth, dizziness, and incoordination; 100 ppm/7 hr caused mild eye, nose, and throat irritation, flushing of the face and neck, headache, somnolence, and slurred speech. Skin contact may produce dermatitis because of perchloroethylene's defatting action (more common after repeated exposure). Direct eye contact causes tearing and burning but no permanent damage. Ingestion is rare but can cause irritation of the lips, mouth and gastrointestinal tract, irregular heartbeat, nausea & vomiting, diarrhea (possibly blood stained), drowsiness, unconsciousness, and risk of pulmonary edema (fluid in lungs). **Chronic Effects:** Prolonged exposure can cause impaired memory, extremity (hands, feet) weakness, peripheral neuropathies, impaired vision, muscle cramps, liver damage (fatty degeneration, necrosis, yellow jaundice, and dark urine) and kidney damage (oliguric uremia, congestion and granular swelling).

FIRST AID Rescuers must not enter areas with potentially high perchloroethylene levels without a self-contained breathing apparatus.

Eyes: Do not allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** Quickly remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. *Never administer adrenalin!* **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that conscious and alert person drink 1 to 2 glasses of water, then induce vomiting. Be sure victim's head is positioned to avoid aspiration of vomitus into the lungs. **Note to Physicians:** Monitor level of consciousness, EEG (abnormalities may indicate chronic toxicity), blood enzyme levels (for 2 to 3 wk after exposure), EKG, adequacy of respirations & oxygenation, and liver and kidney function. **BEIs:** C_2Cl_4 in expired air (10 ppm), sample prior to last shift of work week; C_2Cl_4 in blood (1 mg/L), sample prior to last shift of work week; trichloroacetic acid in urine (7 mg/L), sample at end of workweek.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources (although noncombustible, it forms toxic vapors from thermal decomposition). For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for later disposal. For large spills, dike far ahead of spill and await reclamation or disposal. Report any release in excess of 1 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** If released to soil, perchloroethylene evaporates and some leaches to groundwater. It may absorb slightly to soils with heavy organic matter. Biodegradation may be important in anaerobic soils. In water, it is subject to rapid volatilization with an estimated half-life from <1 day to several weeks. In air, it exists mainly in the vapor-phase and is subject to photooxidation with a half-life of 30 minutes to 2 months. **Ecotoxicity Values:** Guppy (*Poecilia reticulata*), LC_{50} = 18 ppm/7 days; fathead minnow (*Pimephales promelas*), LC_{50} = 18.4 mg/L/96 hr, flow through bioassay. **Disposal:** Consider recovery by distillation. A potential candidate for rotary kiln incineration at 1508 to 2912 °F (820 to 1600 °C) or fluidized bed incineration at 842 to 1796 °F (450 to 980 °C). Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33): No. U210
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 100 lb (45.4 kg) [* per CWA Sec. 307 (a)]
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear a faceshield (8 inch minimum) per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For any detectable concentration, use a supplied-air respirator or SCBA with a full facepiece operated in pressure demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets made of butyl rubber, Neoprene, or Viton to prevent skin contact. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.⁽¹⁰³⁾ **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area away from sunlight, and incompatibles. Do not store sludge from vapor degreasers in tightly-sealed containers and keep outside until disposal is arranged. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Check stabilizer levels frequently and ventilation equipment (air velocity, static pressure, air valve) at least every 3 months. Install an air dryer in ventlines to storage tanks to prevent moisture from rusting and weakening the tank and contaminating or discoloring its contents. Purge all tanks before entering for repairs or cleanup. Build a dike around storage tanks capable of containing all the liquid. Ground tanks to prevent static electricity. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers that emphasize liver, kidney, and nervous system function, and the skin. Alcoholism may be a predisposing factor.

Transportation Data (49 CFR 172.101)

OT Shipping Name: Tetrachloroethylene
OT Hazard Class: 6.1
UN No.: UN1897
OT Packing Group: III
OT Label: Keep away from food
Special Provisions (172.102): N36, T1

Packaging Authorizations
a) Exceptions: 173.153
b) Non-bulk Packaging: 173.203
c) Bulk Packaging: 173.241

Quantity Limitations
a) Passenger Aircraft or Railcar: 60 L
b) Cargo Aircraft Only: 220 L
Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 40

SDS Collection References: 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 140, 148, 149, 153, 159, 163, 164, 167, 168, 171, 174, 175, 176, 180.
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